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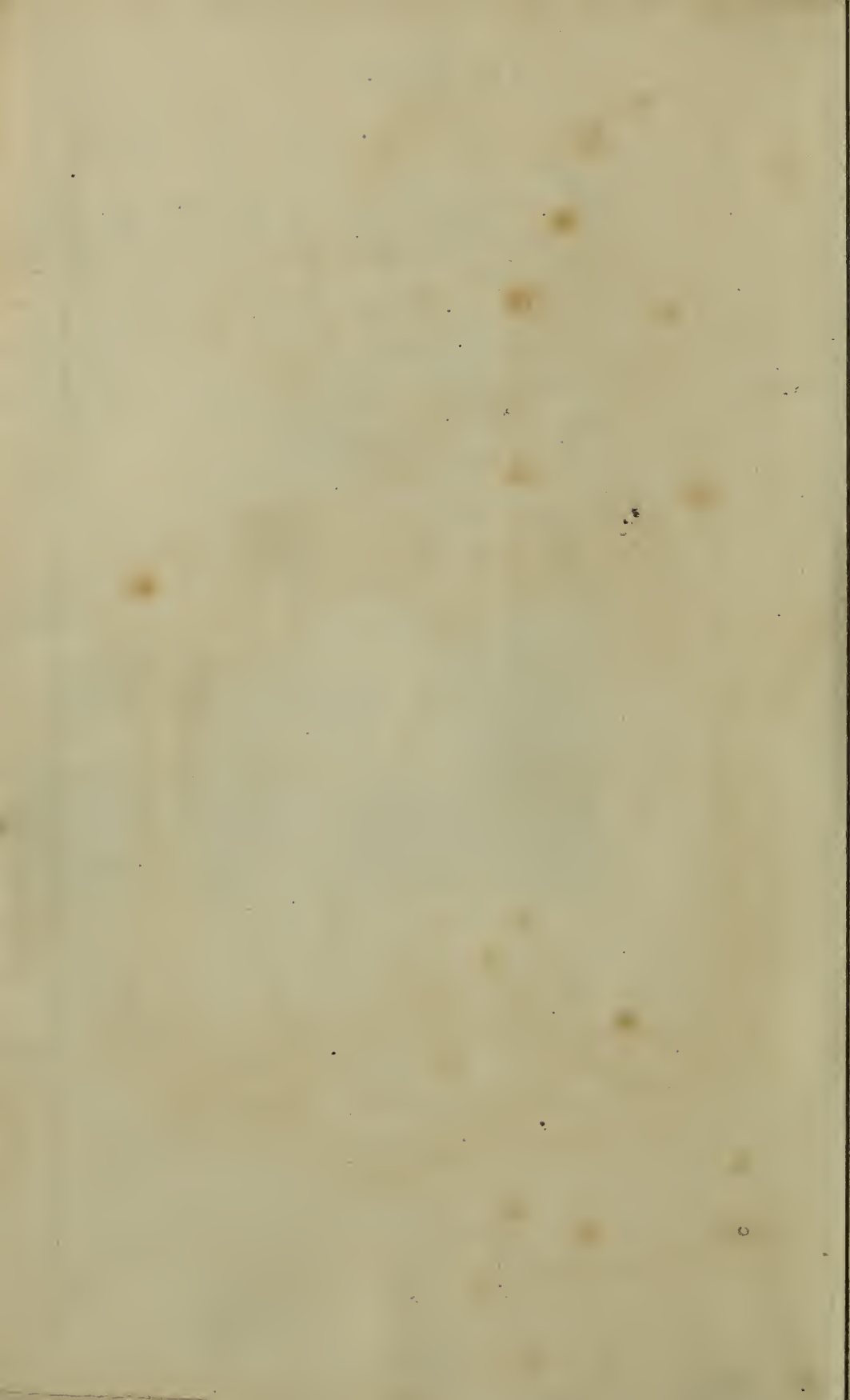
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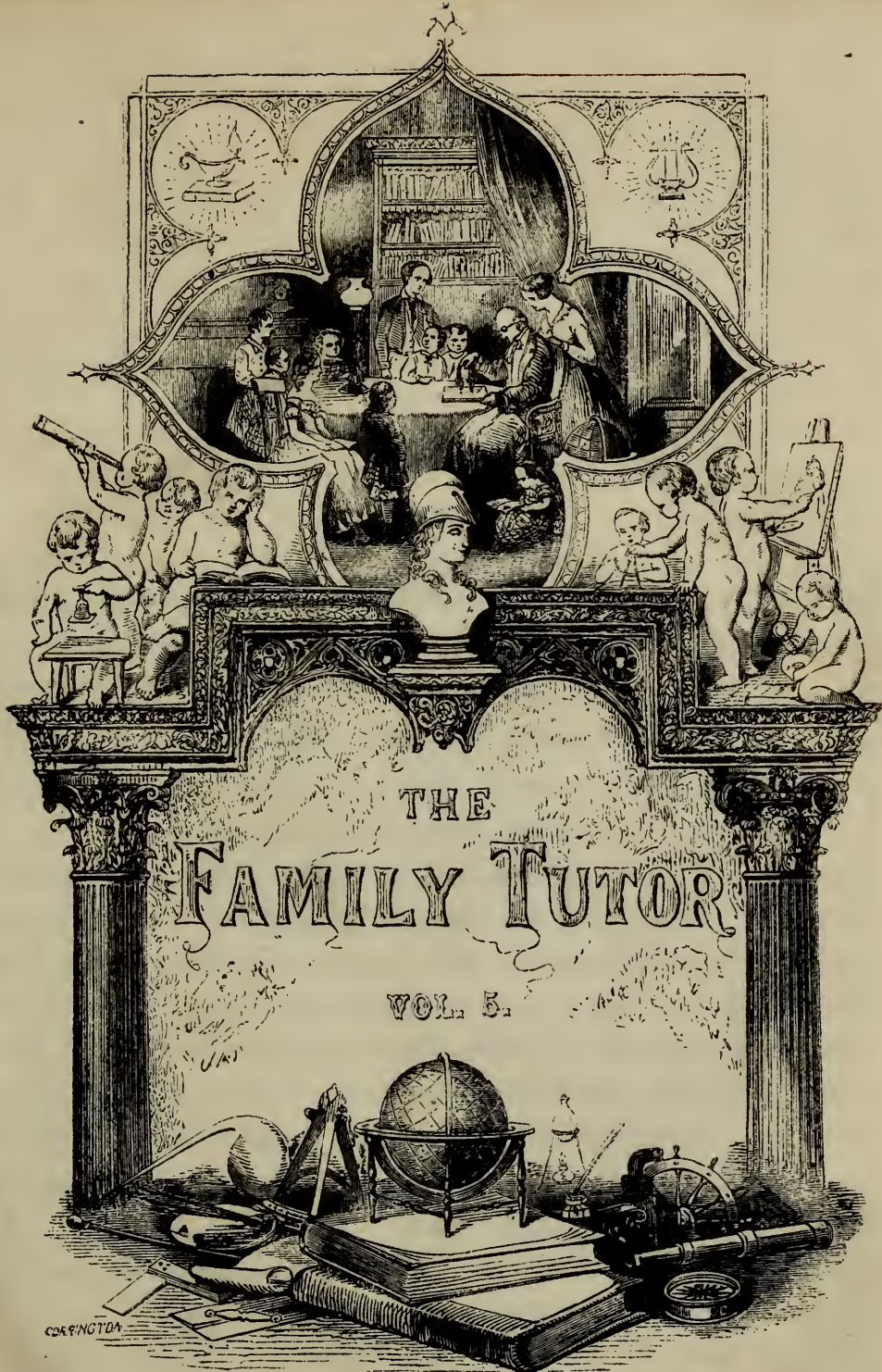


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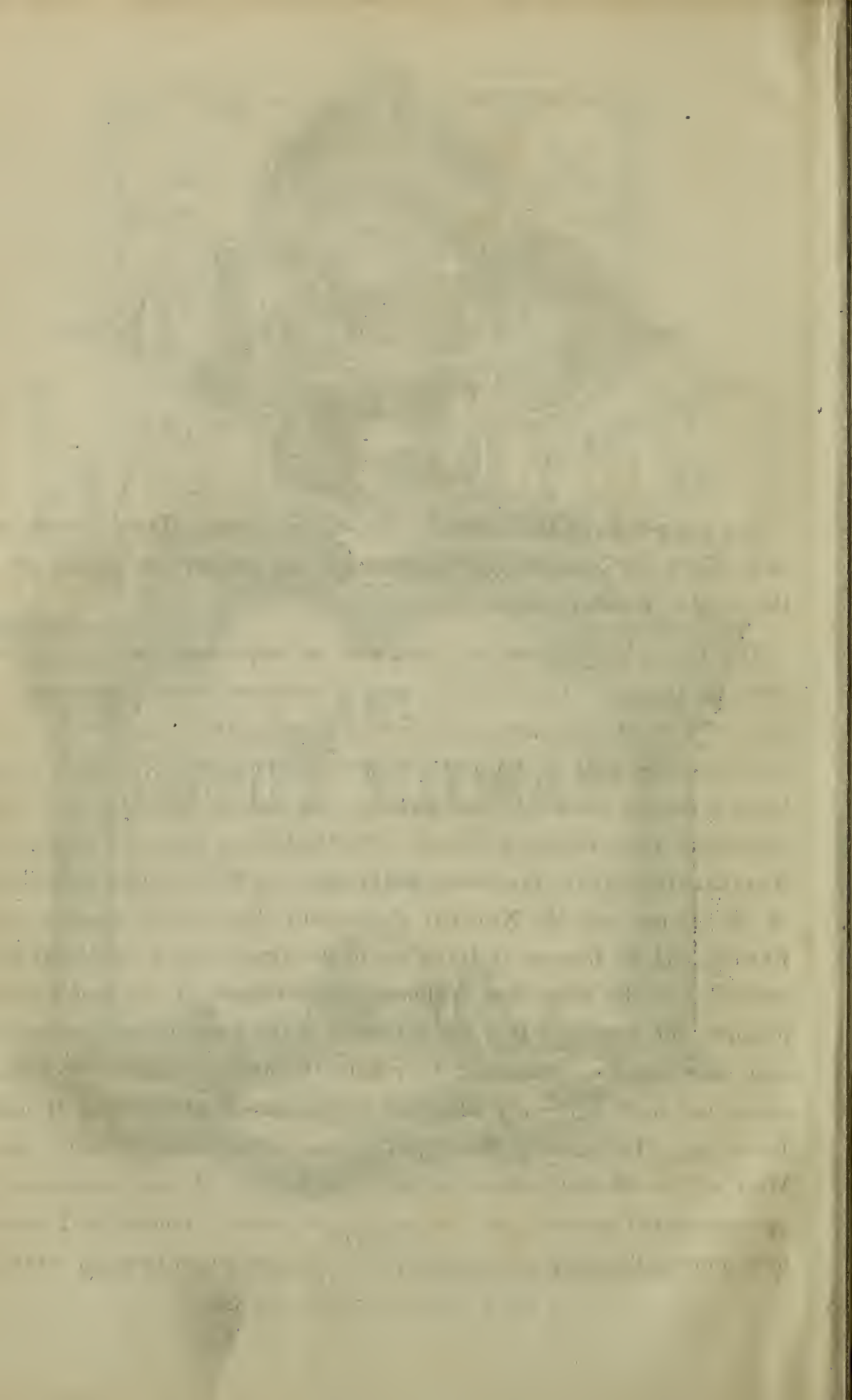
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PREFACE.

THE completion of the Fifth Volume of the FAMILY TUTOR, induces us to offer a few comments on the results of our endeavours to promote the cause of popular instruction.

The TUTOR has progressively assumed an important character as a domestic Teacher. Its value as a work of reference is now appreciated, and we have the assurance of numerous friends that a large amount of usefulness has marked its career to the present time. The principal topics presented in each Volume have been carefully prepared to meet the educational requirements of the age. The treatises on ENGLISH GRAMMAR, NATURAL GEOGRAPHY, ASTRONOMY and GEOLOGY, in the first Four Volumes of the TUTOR, and the NATURAL PHILOSOPHY, CHEMISTRY, LESSONS IN FRENCH, and the LESSONS IN DRAWING, in the present—and which will be concluded in the succeeding Volume—are evidences of the zeal which prompts our labours. It is the intention of the Proprietors to present some new features, combining a system of instruction adapted to both sexes, but more especially addressed to the purpose of assisting Home Education. To facilitate this object a considerable enlargement of the Work will be effected, *without any Increase of Cost*. A more systematic arrangement of material will also be made, in order to render the TUTOR more practically and permanently useful. Sixteen pages in every future

Number will be devoted to directions in the art of teaching, and other matters of interest to the Practical Teacher, whether for Home, Educational, or Professional Reading. A separate paging will distinguish this portion of the Book, and the Volume will extend through the whole Year instead of being completed once in Six Months, as at present.

The other portion of the Work will be devoted to the production of a Series of Books on the various branches of Popular Science, required for Home Education. These books will be written by authors of great experience, and the typography will be of the best description. The paging of these Books will also be separate, and on the completion of each subject, Title-pages will be given to every Book, which can be detached from the FAMILY TUTOR, and become a volume for the School Library. Thus each alternate Number will contain forty-eight pages, being the Cheapest Work connected with Instruction which has yet appeared, besides forming the nucleus of an important addition to the Bookcase on all Educational matters.

INDEX.

CHEMISTRY.

(With numerous Illustrations.)

	Page
Air, Elasticity of the.....	39
Air pump	39
Atmosphere, Limits of the.....	42
„ Weight of the	40
Barometer.....	41
Crystallization—	
Cleavage	190
Cystalline forms	163
Crystallization, Circumstances influencing	162
Crystals, Measurement of.....	191
Dimorphism	193
Goniometer, Wollaston's Reflective	191
Isomorphism	192
Molecules, Polarity of	163
Primary Forms	159
Electricity, Chemical—	
Battery, Daniel's Constant.....	220
„ Grove's	220
„ Smee's	221
Batteries, Sustaining	220
Conditions of Electro-chemical Decomposition	192
Electricity, Effects of Voltaic.....	193
Electro-chemical Decomposition	193
Electrolysis	194
Electro-Metallurgy	221
Voltmeter.....	219
Water, Decomposition of.....	193
Elements and their Laws of Combination—	
Atoms, Specific heat of.....	162
Atomic Theory	161
Chemical Affinity	160
„ Nomenclature	132
„ Symbols	159
Combination by Volume	131
„ Weight	129
Combining numbers of Compounds	131
Definite Proportions	129
Equivalent Proportions.....	130
Multiple Proportions.....	129

	Page
Names and Compounds.....	132
Number and Classification	129
Quaternary Compounds	134
State in which they exist.....	129
Table of Chemical Equivalents.....	130
Heat—	
Expansion	258
„ of Solids and Liquids	261
„ Unequal, of Water	284
Heat	257
„ Absorption of	288
„ Communication of	285
„ Conduction of.....	285
„ Convection of	287
„ Radiant	287
„ Sources of.....	257
„ Specific	321
„ Transmission of, through Bodies.....	320
Melloni's Apparatus	321
Pendulum, Compensation	262
Pyrometers	261
Temperature, Equilibrium of.....	285
Thermometers.....	258
„ Differential	260
„ Self-registering	260
Thermometrical Scales.....	260
Light—	
Light, Analysis of	75
„ Chemical Rays of	77
„ Reflections of.....	7
Natural Colour of Bodies	76
Phosphorescence	78
Polarization	76
Prisms.....	75
Prismatic Colours	75
Refraction, Amount of.....	74
„ Double.....	76
„ Single	74
Spectral Impressions.....	78
Mariotte, Law of.....	40
Matter, General Properties of.....	12
Vacuum	39

Weight and Specific Gravity—	Page
Density	103
Gases	106
Hydrometer	106
Liquids	104
Solids	104
Specific Gravity	103

DRAWING.

Practical Lessons in Drawing (<i>with Illustrations</i>) ..	135, 171
	229, 277, 372

ELOCUTION.

(*With numerous Illustrations.*)

Introduction	7
Articulation	9
„ Defective	72
Aspirates, The	71
Elements, Classification of the	69
Gesture	227, 240, 289, 309, 339
Inflections	167
Melody	168
Mouth, Postures of the	71
Movement	170
Pitch	137
Stammering	107
Time	169
Vocal Gymnastics	9

FRENCH.

Lessons in French	45, 79, 110, 142, 164, 195, 222, 252, 280
	314, 342, 369

MISCELLANEOUS.

Anglo Saxon race, Increase of the	312
Animals, Distribution of	358
Attention, Habit of	230
Aurora Borealis and the Electric Telegraph	350
Bank of England note, The first Forged	319
Benion, The Rev. Samuel, Biography of	25
Berzelius	43
Books, Statistics of	230
Botanical Geography	348, 374
China, Animals of	353
Coral Reefs (<i>with an Illustration</i>)	85
Crops, Rotation of	359
Daguerreotype Process	153
Dates	382
Delays	200
Demosthenes	50
Dropping Well, The (<i>with an Illustration</i>)	24
Education, Happy Effects of	228
Egyptians, Domestic Life and Manners of the Ancient	87
El Dorado of Sir Walter Raleigh	10
Espiritu Santo, The, A Flower	158
Golden Peacock, The, A Story of King Arthur (<i>Illustrated</i>)	172, 234, 292
Greeks and Romans, Books and Writing of the	30
Greek and Roman Youth, Early Education of	55
Halos (<i>with an Illustration</i>)	54
Herald's College	84
Hudson River, First Voyage up the	199
Life? What is	53
Mathematical Problems	98, 150, 170, 199
Meteorology	16, 99
Microscope, How to use the	60

	Page
Minerals, Artificial Formation of	150
Minutes, Use the	308
Months, The (<i>with Illustrations</i>)	
February	113
March	145, 177
April	204, 231
May	265, 297
June	323, 355
July	377
Nineveh, The Seals recently found at	324
Objects, Extreme Smallness of certain	144
Orfila	330
Philosopher's World, The	322
Rain-water	23
Rome and its Rulers	20
Rubens and the Lion	308
Scientific Facts	376
Scott, Sir Walter, Advice to his Son	240
Sea, The, A Great Cemetery	29
Spell, Learning to	313
Teachers, Hints to	18, 42, 208
Telescope, The Craig (<i>with an Illustration</i>)	354
Terms, Importance of the correct use of	270
Time, Proper Distribution of	134
Universities	23
Waynflete, William of, Sketch of his Life	282
You will never be worth your Salt, A True Tale	148
Zamang Tree	360

NATURAL PHILOSOPHY.

(*With numerous Illustrations.*)

Chapter	
I. Properties of Matter	2
II. Physical Forces	6
III. Pneumatics	31
IV. Weight and Pressure of the Air	34
V. „ „	37
VI. „ „	61
VII. Properties of the Air	64
VIII. „ „	67
IX. Properties of Liquids	92
X. Pressure of Liquids	93
XI. Specific Gravity	96
XII. Hydrostatic Pressures and Formation of Fountains	124
XIII. Flowing Liquids and Hydraulic Machines	124
XIV. Hydraulic Machines	128
XV. Rest and Motion	152
XVI. Composition and Resolution of Forces	153
XVII. Inertia	156
XVIII. Gravitation	181
XIX. Descent of Falling Bodies	183
XX. Motion of Inclined Planes	185
XXI. Motion round a Centre	211
XXII. Adhesion and Capillary Attraction	213
XXIII. Properties of Solids	217
XXIV. Centre of Gravity	241
XXV. The Pendulum	245
XXVI. Of Percussion	271
XXVII. The Mechanical Powers	274
XXVIII. The Pulley.—The Wheel and Axle	302
XXIX. The Inclined Plane.—The Wedge.—The Screw	306
XXX. Of Passive or Resisting Forces	331
XXXI. Undulations	334
XXXII. Production of Sound	362
XXXIII. Phenomena of Sound	364

THE TUTOR AND HIS PUPILS.—APPENDIX.

	<i>Paragraph.</i>		<i>Paragraph.</i>
Animals, Respiration of	127	Frugality	89
„ Ruminating Process of	27	Gardens, The Hanging, of Antiquity	20
Army, Commission in the.....	46	Geography, Terms used in	94
Art-education	136	„ Works on.....	11
Arithmetic.....	171	Glass, Ductility of	18
Atmosphere, Height of the	22	Good Honour	123
Bees, Food of	15	Governesses, Dress of	149
Beheading	83	„ Proper Station of.....	54
Bells, Invention of	98	Graphite.....	69
Biography	48	Greece, History of.....	153
Birds, Songs of.....	26	Gypsum	181
Blacklead Pencils	42	Habits, Overcoming Bad	91
Brahe, Tycho	115	Harmony and Counterpoint.....	47
Business, Entering into	5	Heidelberg, University of	102
Cacutcheon Trees	179	Heraldry.....	14
Chapel.....	173	History and Biography, Study of	108
Children, Correct Pronunciation in.....	21	Hydrocarbons	50
„ Cultivation of Memory in.....	172	Infant Schools.....	169
„ Correction of, in Schools.....	6	Inns of Court	161
„ Early Tuition of	119	Inorganic Bodies.....	96
„ Geography for	2	Insects, Collecting.....	157
„ School-hours for Young	42	„ Instinct and Reason of	142
Chromatype	61	Ionian Islands, Population of the.....	107
Churches, Singing in.....	174	Iron and the Magnet.....	10
Coaches, Introduction of, into England.....	71	K, The Use of the Letter	99
Coke	33	Land, Ancient Measurement of.....	97
Colossus of Rhodes	112	Language, The Biscayan	95
College, Choice of	35	„ Study of	87
Colleges at Cambridge, Incomes of the.....	76	Lawyers, Language of.....	80
Commas	30	Literature, Progress of.....	57
Coins, National Collections of	137	Lymphatic Vessels.....	79
Copernicus	120	Macedonians, Origin of the	86
Coral Reefs	53	Magnetism.....	83
Cromlechs.....	85	Magnitude.....	182
Cubit, The ancient Egyptian	93	Making and Manufacturing.....	146
Discipline	113	Measures of Capacity.....	130
Drawing, Elementary	28	Medieval and Middle Ages.....	124
Early Astronomers, False Estimates of the	188	Merchant Service	45
Earth and Sun	84	Metal, Fusible	68
„ Rotation of the	64	Microscope-glasses, Cleaning	24
Ease, Unaffected.....	165	Microscopic Observation, Shells for	164
Education, Objects and Pictures as a Means of	183	Military College at Woolwich, Royal	148
Eggs, Boiled, Discoloration of Silver by	43	Mint, The	131
Egg-hatching by Steam	12	Money, Relative Value of.....	135
Elasticity	19	Mouths	58
Electrical Machines	23	Music, Ancient	177
Elocution	185	„ Proficiency in.....	186
Emphasis	81	Myrtle, The	160
England, Bank of, Clerkships in the	59	Navy, The Royal.....	37
English Grammar	63, 167	Numismatic Society	144
English Language	51, 60	Paper	13
Engravings, Transfer of, on Glass	138	Periods	29
Entomological Society.....	129	Petersburg, St., Founding of.....	106
Etiquette, False	143	Phidias	109
Etna, Measurement of	104	Phonetic and Phototypy	39
Exercise, Muscular	66	Phonography	32
Exercises for Young Ladies	162	Photogenic Drawings, To make	156
Fishes, Migration of	72	Physical Development	42
Flax	90	Punchbeck.....	100
Flowers, Night-closing.....	158	Pitt's Bridge.....	111
French Language	17	Plants, Dried	175
„ Measures	150	„ Mineral Food of	121
Friends, Rule of Conduct among	55	Platinum Sponge	101

	Paragraph.		Paragraph.
Post-office in England, The first	155	Speaking Conducive to Health	65
Poems, Different Kinds of	163	„ Trumpets	163
Profession, Choice of a	126	Squinting	125
Psalmody, Metrical	114	Squirrels	180
Pyramids	152	Steamboats, first, in England	3
Quotations	92	Studies regular	16
Rain	36	Teachers, Conduct to	122
Reporters	116	„ School	4
Richard Cœur-de-lion and the Bee-hives	75	„ Situation of.....	166
Rome, Niebuhr's History of	173	Teeth, Care of the.....	154
Rome, the City of.....	118	Telescope, Invention of the	7
Roman Computation of Money.....	159	„ Sir Isaac Newton's reflecting.....	132
„ Foot, the Ancient	82	„ Water	141
„ Names of the Days of the Week	105	Teredo, the	110
„ Literature, Ages of	139	Tobacco.....	151
Rose	73	Transport	70
Russian Empire	77	Vegetable Diet	134
School Education	147	Vegetables, Effect of Light and Air on	138
„ Hours for Young Children	41	Vegetable Kingdom	140
„ Lessons	25	Voice, Cultivation of the	52, 170
„ Exhibitions, private	133	„ Range of the Human	73
„ Proper Age for.....	34	Weeds, Utility of	56
„ Punctual Attendance at.....	40	Welsh Language	1
Sea-weeds, growth of, from seeds	67	Water, Composition of.....	187
Self-education.....	8	Waves, Cause of.....	134
Short-hand writers	41	Wax, Vegetable.....	176
Singularity	117	Wind, Velocity of the	103
Smoking	9	Wood	74
Sound.....	61	Words, Choice of	31
Sound and Noise	145	Writing, Facility in	123

NATURAL PHILOSOPHY;

BY PROFESSOR DRAPER.

EDITED, WITH NOTES, BY W. T. K.

INTRODUCTION.

THE main object of a teacher should be to communicate a clear and general view of the great features of his science, and to do this in an agreeable and short manner. It is too often forgotten that the beginner knows nothing; and the first thing to be done is to awaken in him an interest in the study, and to present to him a view of the scientific relations of those natural objects with which he is most familiar. When his curiosity is aroused, he will readily go through things that are abstract and forbidding; which, had they been presented at first, would have discouraged or perhaps disgusted him.

I am persuaded that the superficial knowledge of the physical sciences which so extensively prevails is, in the main, due to the course commonly pursued by teachers. The theory of Forces and of Equilibrium, the laws and phenomena of Motion, are not things likely to allure a beginner; but there is no one so dull as to fail being interested with the wonderful effects of the weight, the pressure, or the elasticity of the air. It may be more consistent with a rigorous course to present the sterner features of science first; but the object of instruction is more certainly attained by offering the agreeable.

There are two different methods in which Natural Philosophy is now taught:—1st, As an experimental science; 2nd, As a branch of mathematics. Each has its own peculiar advantages; and the public teacher will follow the one or the other, according as it is his aim to store the mind of his pupil with a knowledge of the great facts of Nature, or only to give it that drilling which arises from geometrical pursuits. From an extensive comparison of the advantages of these systems, I believe that the proper course is to teach physical science experimentally first—a conviction not only arising from considerations respecting the constitution of the human mind, the amount of mathematical knowledge which students commonly possess, but also from the history of these sciences. Why is it that the most acute mathematicians and metaphysicians, the world has ever produced for two thousand years made so little advance in knowledge; and why have the last two centuries produced such a wonderful revolution in human affairs? It is from the lesson first taught by Lord Bacon, that, so liable to fallacy are the operations of the intellect, experiment must always be the great engine of human discovery,—and, therefore, of human advancement.

JOHN WILLIAM DRAPER.

[In editing the papers by Professor Draper, upon Natural Philosophy, I have introduced additional matter between brackets; so that the series, as they are now presented to the reader, include the most recent improvements and important discoveries in the various branches of this delightful science. Every standard work has been consulted, various experiments performed, and nothing has been left undone that could render the series attractive, instructive,—and, in fact, the best work of the present day. In order to render the descriptions even more lucid, nearly four hundred woodcuts have been engraven expressly for this work,—another proof that we have not spared expense as well as labour.—W. T. K.]

NATURAL PHILOSOPHY.—ELEMENTARY PRINCIPLES.

CHAPTER I.

PROPERTIES OF MATTER. — *The Three Forms of Matter—Vapours—The distinctive, essential, and accessory properties—Extension—Impenetrability—Unchangeability—Illustrations of Extension—Methods of measuring small spaces—The Spherometer—Illustration of Impenetrability—The Diving-Bell—The accessory properties of Matter—Compressibility—Expansibility—Elasticity—Limit of Elasticity—Illustrations of Divisibility—Porosity and interstitial spaces—Weight.*

MATERIAL substances present themselves to us under three different conditions. Some have their parts so strongly attached to each other that they resist the intrusion of external bodies, and can retain any shape that may be given them. These constitute the group of **SOLIDS**. A second class yields readily to pressure or movement, their particles easily sliding over one another; and from this extreme mobility they are unable of themselves to assume determinate forms, but always copy the shape of the receptacles or vessels in which they are placed—they are **LIQUIDS**. A third, yielding even more easily than the foregoing, thin and aerial in their character, and marked by the facility with which they may be compressed into smaller or dilated into larger dimensions, give us a group designated as **GASES**. Metals may be taken as examples of the first; water as the type of the second; and atmospheric air of the third of these states or conditions, which are called "the **THREE FORMS** of bodies."

In some instances the same substance can exhibit all three of these forms. Thus, when liquid water is cooled to a certain degree, it takes on the solid condition, as ice or snow; and when its temperature is sufficiently raised, it assumes the gaseous state, and is then known as steam. Writers on Natural Philosophy have found it convenient, for many reasons, to introduce the term *Vapours*, meaning by that a gas placed under such circumstances that it is ready to assume the liquid state. As the steam of water conforms to this condition, it is therefore regarded as a vapour.

Under whichever of these forms material substances are presented, they exhibit certain properties: these are, first, **Distinctive**; second, **Essential**; third, **Accessory**.

There is a certain bright white metal passing under the name of Potassium, the *distinctive* character of which is, that, when thrown on the surface of water, it gives rise to a violent reaction, a beautiful violet-coloured flame being evolved. A piece of lead, which, to external appearance, is not unlike the potassium, when brought in contact with water, exhibits no such phenomenon, but, as every one knows, remains quietly, neither disturbing the water nor being acted upon by it.



Fig. 1.

Such distinctive qualities are the objects of a Chemist's studies. It belongs to his science to show how some gases are coloured and others colourless; some supporters of combustion, while others extinguish burning bodies; how some liquids can be decomposed by Voltaic batteries and some by exposure to a red heat. The general doctrines of affinity, the modes in which bodies combine, and the characters of the products to which they give rise—all these belong to Chemistry.

But beyond these distinctive qualities of bodies, there are, as has been observed, certain other properties which are uniformly met with in all bodies whatever, and hence are spoken of as **ESSENTIAL**. They are,

Extension.

Impenetrability.

Unchangeability.

By **EXTENSION** we mean that all substances, whatever their volume or figure may be, occupy a determinate portion of space. We measure them by three dimensions—length, breadth, and thickness.

IMPENETRABILITY points out the fact that two bodies cannot occupy the same space at the same time. If a nail is driven into wood, it enters only by separating the woody particles from each other; if it be dropped into water, it does not penetrate, but displaces the watery particles: and even in the case of aerial bodies, through which masses can move with apparently little resistance, the same observation holds good. Thus, if we take a wide-mouthed bottle, *a* Fig. 2, and insert through its cork a funnel, *b*, with a narrow neck, and also a bent tube, *c*, which dips into a glass of water, *d*, on pouring any liquid into the funnel, so that it may fall, drop by drop, into the bottle, we shall find, as this takes place, that air passes out, bubble after bubble, through the water in *d*. The air is, therefore, not penetrated by the water, but displaced.

Fig. 2.

The same fact may also be proved by taking a cupping-glass, *a*, Fig. 3, and immersing it, mouth downward, in a glass of water, *b*. If the aperture, *c*, of the cupping-glass be left open the air will rush out through it, and the water flow in below: but if it be closed by the finger, as the air can now no longer escape, the water is unable to enter and occupy its place.

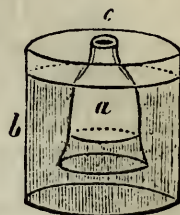


Fig. 3.

Similar experiments establish the impenetrability of liquids by solids. If in a glass of water, Fig. 4, a leaden bullet is immersed, it will be seen that as the bullet is introduced the water rises to a higher level, showing, therefore, that a liquid can no more be penetrated by a solid than, as was seen in the former experiment, can a gas by a liquid. Two bodies cannot occupy the same space at the same time.



Fig. 4.

The third essential property of matter is its **UNCHANGEABILITY**. This property may be looked upon as the foundation of Chemistry; and though there are many phenomena which we constantly witness which seem to contradict it, they form, when properly considered, striking illustrations of the great truth that material substances can neither be created nor destroyed; and that the distinctive qualities which appertain to them remain for ever unchanged. The disappearance of oil in the combustion of lamps, the burning away of coal, the evaporation of water, when minutely examined, far from proving the perishability of matter, afford the most striking evidence of its duration. Nor is a solitary fact known in the whole range of Chemistry, Natural Philosophy, or Physiology, which lends the remotest countenance to the opinion that, either by the slow lapse of time or by any artificial processes whatever, can matter be created, changed, or destroyed. Even the bodies of men and animals, the structures of plants, and all other objects in the world of organization, which seem characterized by the facility with which they undergo unceasing and, eventually, total change, are no exceptions to the truth of this observation. The bodies which we possess to-day are made up of particles which have formed the bodies of other animals in former times, and which will again discharge the same duty for races that will hereafter come into existence.

As illustrations connected with the extension and impenetrability of matter, I may give the following instances:

We are frequently required to measure the dimensions of bodies; that is, to determine their length, breadth, or thickness. It is a much more difficult thing to do this accurately than is commonly supposed. It requires an artist of the highest skill to make a measure which is a foot or a yard in length, or which shall contain precisely a pint or a gallon. With a view of facilitating the measurement of bodies, a great many contrivances have been invented, such as verniers, spherometers, and screw machines of different kinds.

The spherometer, which is a beautiful contrivance for measuring the thickness of bodies, is constructed as follows: It has three horizontal steel branches, *a*, *b*, *c*, Fig. 5, which form with each other angles of 120 degrees. From the extremities of these

branches there proceed three delicate steel feet, *d, e, f*, and through the centre, where the branches unite, a screw, *g*, the thread of which is cut with great precision, and which terminates in a pointed foot, *i*, passes. The head of this screw carries a divided circle, *m*. Now, suppose the instrument is placed on a piece of flat glass, it will be supported on its three feet, which are all in the same plane; but if in turning the screw we depress its point, *i*, beneath the plane of its feet, it can no longer stand with stability on the glass, but totters when it is touched, and emits a rattling sound. By altering the screw, therefore, we can give it such a position that both by the finger and the ear we discover that its point is level with the points *d, e, f*. Now, let the object, the thickness of which is to be measured, be placed on the glass, and the screw turned until the instrument stands without tottering; it is obvious that its point must have been lifted through a distance precisely equal to the thickness of the object to be measured, and the movement of the head of the screw—read off upon the scale *n*, against which it works, indicates what that thickness is.

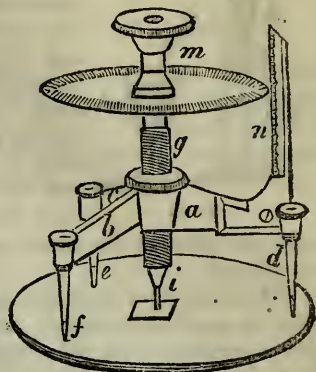


Fig. 5.

This instrument, therefore, serves to show, that in the measurement of small spaces, the senses of touch and hearing may often be resorted to with more effect than the eye. The spherometer is here introduced in connection with these general considerations respecting the extension of matter, as affording the student an illustration of the delicate methods we possess of determining the minutest dimensions of bodies.

As an illustration of the impenetrability of matter, the machine which passes under the name of the diving-bell may be mentioned. It consists of a vessel, *a a*, Fig. 6, of any suitable shape, and heavy enough to sink in water when plunged with its mouth downward.* Owing to the impenetrability of the air, the water is excluded from the interior, or only finds access to such an extent as corresponds to the pressure of the depth to which it is sunk. Light is admitted to the bell through thick pieces of glass in its top, and a constant stream of fresh air thrown into it from a tube, *b*, and forcing-pump above, the atmosphere in the inside being suffered to escape through a stop-cock as it becomes vitiated by the respiration of the workmen. Diving-bells are extensively resorted to in submarine architecture, and for the recovery of treasure lost in the sea.



Fig. 6.

Having disposed of the *essential*, we pass next to a consideration of the *accessory properties* of matter. They are,—

Compressibility.
Divisibility.

Expansibility.
Porosity.

Elasticity.
Weight.

That substances of all the three forms are compressible is capable of easy proof. In the process of coining, pieces of metal are exposed to powerful pressure between the steel dies, so that they become much denser than before. By enclosing water or any other liquid in a strong vessel, and causing a piston, driven by a screw, to act upon it, it may be reduced to a less space, and gaseous substances, such as atmospheric air, when enclosed in an India-rubber bag, or even a bladder, may be compressed by the hands.

Under the influence of heat all substances expand. This may be proved for such solids as metals, by the apparatus represented in Fig. 7. It consists of a stout board, *a, b*, on which are fastened two brass uprights, *c, d*, with notches cut in them, so as to receive the ends of a metallic bar, *e*. This bar is slightly shorter than the whole

* In our last Volume, at page 8, paragraph 74 of the Appendix, we gave an illustration of the diving-bell previous to its submersion.

distance between the notches, so that when it is set in its place, it can be moved backward and forward, and emits a rattling sound. But if boiling water be poured upon it, it expands and occupies the whole distance, and can no longer be moved.

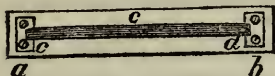


Fig. 7.

[A very simple manner of illustrating the expansion of metals by heat is shown in the following diagram. A plate of brass or other metal is made of the same shape as the upper one in the above figure, and a rod of metal—the same kind as the plate—is fixed to a metal stem inserted in a wooden handle, as *d c*. The rod is made to fit the hole *b*, and also the space *a*, between the two ends. When the metallic rod is plunged into hot water, or heated over the flame of a spirit lamp, the expansion is so great, that it becomes impossible to pass the end of the rod through the hole *b* or the space *a*.—W. T. K.]

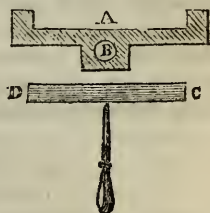


Fig. 8.

The expansion of liquids is well shown in the case of common thermometers, which contain either quicksilver or spirits of wine, those substances occupying a greater volume as their temperature rises. The air-thermometer proves the same thing for gases.

By elasticity we mean that quality by which bodies, when their form has been changed, endeavour to recover their original shape. In this respect there are great differences. Steel, ivory, India-rubber, are highly elastic; lead, putty, and clay, less so. Perfectly elastic bodies resist the action of disturbing causes without any ulterior change; thus, a quantity of atmospheric air, compressed into a copper globe, recovers its original volume as soon as the pressure is removed, though it may have been shut up for years. By the *limit of elasticity* we mean the smallest force which is required to produce a permanent disturbance in the structure of an imperfectly elastic body. No solid is perfectly elastic. An iron wire, drawn a little aside, recovers its original straightness; but if more violently bent, it takes a permanent set, because its limit of elasticity is overpassed. The elasticity of a given substance can often be altered by mechanical processes, such as by hammering, or by heating and cooling, as in the process of tempering.

The divisibility of matter may be proved in many ways. By various mechanical processes, metals may often be reduced to an extreme degree of tenuity; thus it is said, that gold-leaf may be beaten out until it is only $\frac{1}{200000}$ of an inch thick. By chemical experiments, a grain of copper or of iron may be divided into many millions of parts. For certain purposes artists have ruled parallel lines upon glass, with a diamond point, so close to each other, that ten thousand are contained in a single inch. The odours which are exhaled by strong-smelling perfumes, as musk, will for years together infect the air of a large room, and yet the loss of weight by the musk is imperceptible. Again, there are animals whose bodies are so minute, that they can only be seen by the aid of the microscope. The siliceous cells of such infusorials occur in many parts of the earth as fossils. Ehrenberg has shown that tripoli, a mineral used in the arts, is made up of these—a single cubic inch of it containing about forty-one thousand millions—that is, about fifty times as many individuals as there are of human beings on the face of the globe.

As substances of all kinds may be reduced to smaller dimensions, either by pressure or the influence of cold, and as it is impossible for two particles to occupy the same place at the same time, or even for one of them partially to encroach on the position occupied by the other, it necessarily follows, that there must be pores or interstices even in the densest bodies.



[The annexed diagram will illustrate the interstitial spaces between the atoms of bodies, and this may be further demonstrated by the following simple experiment. Place marbles in a jar until it will not hold any more, and you will find that there are spaces between the marbles, because

Fig. 9.

you may afterwards add shot and sand, and finally water.—W. T. K.]

Thus quicksilver will readily soak into the pores of gold, and gases ooze through

India-rubber. Writers on Natural Philosophy usually restrict the term "pore" to spaces which are visible to the eye, and designate those minute distances which separate the ultimate particles of bodies by the term "interstices."

All bodies have weight or gravity. It is this which causes them to fall, when unsupported, to the ground; or when supported, to exert pressure upon the supporting body. Nor is this property limited to terrestrial objects; for in the same way that an apple tends to fall to the earth, so too does the moon; and all the planets gravitate toward each other and toward the sun. It was the consideration of this principle that led M. Leverrier to the discovery of a new planet beyond Uranus—this latter star being evidently disturbed in its movements by the influences of a more distant body hitherto unknown.

CHAPTER II.

PHYSICAL FORCES.

Attractive and repulsive forces—Molecular attraction—Gravitation—Cohesion—Constitution of Matter.

ALL changes taking place in the system of nature are due to the operation of forces. The attractive force of the earth causes bodies to fall, and a similar agency gives rise to the shrinking of substances—their parts coming closer together when they are exposed to the action of cold. In like manner, when an ivory ball is suffered to drop on a marble slab, its particles, which have been driven closer to one another by the force of the blow, instantly recover their original positions by repelling one another; that is to say, through the agency of a repulsive force. Of the nature of forces we know nothing. Their existence only is inferred from the effects they produce; and according to the nature of those effects, we divide them into ATTRACTIVE and REPULSIVE FORCES—the former tending to bring bodies closer together, the latter to remove them farther apart.

It has been found convenient to divide attractive forces into three groups, according as the range of their action, or the circumstances of their development differ. When the attractive influence extends only to a limited space, it is spoken of as *molecular attraction*; but the attraction of gravitation is felt throughout the regions of space. By cohesion is meant an attractive influence called into existence when bodies are brought to touch one another. It is to be understood that these are only conventional distinctions; and it is not improbable that all the phenomena of attraction are due to the agency of one common cause.

Chemists have shown that, in all probability, material substances are constituted upon one common type. They are made up of minute, indivisible particles, called atoms, which are arranged at variable distances from each other. These distances are determined by the relative prevalence of attractive and repulsive forces, resident in or among the particles themselves; and so too is the form of the resulting mass. If the cohesive predominates over the repulsive force, a solid body is the result; if the two are equal, it is a liquid; and if the repulsive prevails, it is a gas.

There are many reasons which lead us to suppose that the repulsive force, which thus tends to keep the particles of matter asunder, is the agent, otherwise known as heat. Whenever the temperature of a body rises, it enlarges in volume, because its constituent particles move from each other, and on the temperature falling, the reverse effect ensues. If, as many very eminent philosophers believe, heat and light are in reality the same agent, it follows, by a necessary consequence, as will be gathered from what we shall hereafter have to say on optics, that the atoms of bodies vibrate unceasingly, and that instead of there being that perfect acquiescence among them which a superficial examination suggests, all material substances are the seat of oscillatory movements, many millions of which are executed in the space of a single second of time: the number increasing as the temperature rises, and diminishing as it falls.

(To be continued.)

SYSTEM OF ELOCUTION.

BY DR. ANDREW COMSTOCK.

INTRODUCTION.

MAN is designed for action. Nature has so constituted him, that both body and mind require daily exercise to develop their powers, and maintain them in a vigorous and healthy condition. The truth of this remark is manifest from constant observation and experience—those who lead active, bustling lives, conjoined with temperance and prudence, commonly possess robust frames, and healthy constitutions; while the sedentary and the indolent are enervated and sickly.

We find the same results from the exercise of the mental faculties. He whose mind is constantly employed in the acquisition of knowledge, usually retains his mental faculties unimpaired to the last. But not so with the man of ease and indolence. After the meridian of life, the powers of his mind, with those of the body, become weaker and weaker, and he finally leaves the world as he entered it—a child.

The health and strength of the body, therefore, mainly depend on the number of muscles that are frequently called into action, and the degree of rational exercise through which they pass. Now there are few, if any, whose daily avocations are so varied as to bring into requisition *all* the muscles of the body; hence the necessity of *gymnastic* exercises.

The term, *gymnastics*, in its widest sense, signifies all bodily exercises; in a more limited sense, “exercises systematically adapted to develop the physical powers, and preserve them in perfection, which constitutes the *art of gymnastics* properly so called.”

These exercises, when commenced in youth, develop the muscles, give agility to the limbs, and promote the various functions of the animal system: in this way they impart strength and consistency to the body, and lay the foundation of lasting health: and even when commenced in manhood, they invigorate the frame, and brace it against the infirmities of age.

By the frequent and energetic exercise of the muscles, they are brought completely under the control of volition, which is a powerful auxiliary to every variety of action. Hence gymnastics are not only useful because they exert a healthful influence upon the body; but because they lay a good foundation for the easy acquisition of every mechanic art.

From what has been said of gymnastics in general, it may readily be conceived that very important advantages may be derived from *vocal gymnastics*.

By the term, *VOCAL GYMNASTICS*, may be understood the principles of the human voice as employed in speech and song, as well as the training of the organs by which this voice is produced. The principles are the *science* of the voice—the training, the exercise of the organs, necessary to develop their powers, and enable them to act with rapidity, precision, and effect.

Vocal gymnastics give the pupil complete command of the muscles of articulation, extend the compass of the voice, and render it smooth, powerful, and melodious. They not only call forth all the energies of the vocal organs, correct stammering, lisping, &c.; but they invigorate the lungs, and, consequently, fortify them against the invasion of disease.

All the blood, in the course of its circulation, passes through the lungs, where it undergoes a change, not only essential to health, but also to life. Whenever their function, therefore, is interrupted by debility, or disease, the blood is deteriorated, and the whole system suffers; in fact, the very citadel of life is sapped, and nothing but a restoration of these organs to their natural condition, will effect a return of general health. Indeed, the lungs are of so much importance in the animal economy, that the complete suspension of their office is followed by speedy dissolution.

Hence, such healthful measures should be adopted as are calculated to invigorate the pulmonary apparatus, and enable it to maintain its integrity. One of the most hopeful expedients for this purpose, is a well-regulated and persevering course of vocal gymnastics.

Were we to exercise our voices a few

minutes every day, according to just principles, the number of deaths from pulmonary affections, especially consumption, I have no doubt, would be greatly diminished.

While vocal gymnastics give a keenness to appetite, they are a powerful means of promoting digestion. A young clergyman entered my vocal gymnasium, for the purpose of improving his elocution as well as his health. He laboured under dyspepsia, which was attended with loss of appetite, general debility, languor, and dejection of spirits. But in twelve days after he commenced the exercises, there was a radical change in his mental and physical condition: he had become very cheerful; and, to use his own words, his appetite was *ravenous*. Nor is this a solitary case—numerous others might be cited with the like happy result.

My pupils have frequently told me that they always feel invigorated by the exercises. A gentleman, who was formerly a pupil of mine, and who had been in the practice of resorting to a common gymnasium for the benefit of his health, assured me that he derived more advantage from his vocal, than from his athletic exercises. Let the individuals, therefore, who visit those gymnasia, designed only for the exercise of the limbs, not neglect the equally important gymnastics of the pulmonary organs.

Preliminary Observations.—As ELOCUTION is intimately connected with the voice, and as every reader may not be prepared to enter upon a minute development of its various principles, the following preliminary observations may be of some advantage.

Voice is sound, produced by the agitation of air when forcibly expelled from the lungs.

The attributes of the voice, are *general* and *special*. The general attributes are *pitch*, and *force*, and are common to *all* voices. The *special* attributes are those peculiarities which render one voice more agreeable, or disagreeable, than another, as *sweetness*, *harshness*, &c.

The acuteness and gravity of the voice depend on the contractions and dilatations of the vocal tube.

The degree of loudness of the voice, is in proportion to the expulsive effort, and

to the resistance which the air meets on its passage through the glottis.

When air is forcibly expelled from the lungs, and not sufficient resistance given to its egress to produce what is generally understood by the term *voice*, an aspirated, or whispered sound is the result.

From voice articulated by the motions of the lips, tongue, and other parts of the mouth, is produced *oral language*. Hence oral language is not inaptly termed *articulated voice*.

There are two varieties of oral language—*song* and *speech*. In several respects they resemble each other. Thus the notes, both of song and speech, vary in pitch, force, and time. The most striking difference between them, is this: a note of song is maintained in one range of pitch from its commencement to its termination; but a note of speech is varied in pitch during its prolongation. If you prolong the letter *a*, in one range of pitch, thus:

a —————

you will have an example of a note of song. If you utter it interrogatively and affirmatively, thus:

á ? à.

you will have two varieties of the note of speech: the voice in the interrogation, moving from a grave pitch to one more acute; in the affirmation, from acute to grave.

Perhaps enough has been said by way of preliminaries. The principles here mentioned, together with the various others, are methodically presented, fully discussed, and diagrammatically illustrated, in the course of the work.

ELOCUTION is vocal delivery. It may be said to comprise both a *science* and an *art*. The science embraces the principles which constitute the basis of reading and speaking; the art, the practical application of these principles.

Elocution is naturally divided into two parts; namely, *Vocal Gymnastics* and *Gesture*.

Vocal Gymnastics is the philosophy of the human voice, as well as the art of training the vocal organs in speech and song.

Gesture is the various postures and motions employed in vocal delivery.

PART I.

Vocal Gymnastics.—Vocal Gymnastics is the philosophy of the human voice, as well as the art of training the vocal organs, in speech and song.

Vocal Gymnastics is subdivided as follows :

- | | |
|------------------|-----------|
| 1. ARTICULATION, | 3. FORCE, |
| 2. PITCH, | 4. TIME. |

ARTICULATION is the act of forming, with the organs of speech, the elements of vocal language.

PITCH is the degree of the elevation of sounds.

FORCE is the degree of the loudness of sounds.

TIME is the measure of sounds in regard to their duration.

SECTION I.

Articulation.—Articulation is the act of forming, with the organs of speech, the elements of vocal language.

These elements may be formed separately, as in the utterance of the letters of the alphabet, as well as conjunctively, as in the pronunciation of words.

By the utterance of the letters of the alphabet is not meant the pronunciation of the mere *names* of the letters, but the formation of the various *sounds* which the letters represent.

A good articulation is the *perfect* utterance of the elements of vocal language.

The first step towards becoming a good elocutionist, is a *correct articulation*. "A public speaker, possessed of only a moderate voice, if he articulates correctly, will be better understood, and heard with greater pleasure, than one who vociferates without judgment. The voice of the latter may indeed extend to a considerable distance, but the sound is dissipated in confusion. Of the former voice not the smallest vibration is wasted, every stroke is perceived at the utmost distance to which it reaches, and hence it has often the appearance of penetrating even farther than one which is loud, but badly articulated.

"In just articulation, the words are not to be hurried over, nor precipitated syllable over syllable; nor, as it were, melted together into a mass of confusion: they should not be trailed, or drawled, nor per-

mitted to slip out carelessly, so as to drop unfinished. They should be delivered from the lips as beautiful coins newly issued from the mint, deeply and accurately impressed, neatly struck by the proper organs, distinct, in due succession, and of due weight."

Without good articulation, it is impossible to be a correct reader, or speaker. Those who have been accustomed to pronounce their words in a careless or slovenly manner, will find it difficult, even with their best efforts, to utter them distinctly. The organs of articulation, for the want of proper exercise, become, as it were, paralyzed. The pupil, therefore, at the very commencement of his studies, should be conducted through a series of exercises, calculated to strengthen the muscles of articulation, and render them obedient to the will. The best method for effecting these purposes, is to exercise the voice on the elements of speech; first, on each element separately;* secondly, on various combinations.

The elements of the English Language.—The elements of vocal language are the sounds of which words are composed. These sounds are represented by graphic characters, called letters.

The number of *letters* in the English language, is twenty-six; but the number of *elements* is thirty-eight. Hence, as the number of elements exceeds the number of their literal signs, the same letter is employed, in different situations, to represent different sounds. Thus *a* represents four different sounds; *e*, two; *i*, two; *o*, three; *u*, three; *z*, two; and there are six sounds, each of which is represented by two letters—*ou*, *ng*, *sh*, *wh*, *th* in *then*, and *th* in *thin*. If we had a perfect alphabet, every elementary sound would be represented by its appropriate character. †

* "When the elements are pronounced singly, they may receive a concentration of the organic effort, which gives them a clearness of sound and a definite outline, if I may so speak, at their extremes, that make a fine preparative for a distinct and forcible pronunciation in the compounds of speech."—*Rush's Philosophy of the Human Voice*.

† That men have accomplished much by furnishing the world with literature, art, and science, will be conceded by all. Nor will it be denied by any that there remains much to be done to carry all human institutions to their acme of excellence. Among the numerous

EL DORADO OF SIR WALTER RALEIGH.

THE term *El Dorado* is commonly considered to have been the sovereignty teeming with precious metals, which had long been sought for in vain by Spanish adventurers. Their expeditions in quest of it were directed to the interior of the vast region lying between the Orinoco and the Amazon, or Guiana. The rocks were represented as impregnated with gold, the veins of which lay so near the surface, as to make it shine with a dazzling resplendency. The capital, Manoa, was said to consist of houses covered with plates of gold, and to be built upon a vast lake, named Parima, the sands of which were auriferous.

proofs that our institutions have not attained their highest possible degree of perfection, is the fact that the world is now furnished with as much genius for contrivance, wisdom for invention, and judgment for application, as at any former period. He, therefore, who advocates the doctrine of present perfection in human productions, suggests, at least, the possibility that that amount of mind which is unnecessary to the successful application of the present principles, means, and inventions to their respective purposes, is rendered a redundancy by the want of appropriate subjects upon which to operate. The English language, though by no means far advanced in years, has already been the subject of much concurrent, and individual action; yet there is hardly one part of it which is not marred with defect, or deficiency. Even the English alphabet suffers from both these imperfections. To attain perfection in anything, is, perhaps, beyond the power of man, especially in the medium of communicating his ideas. But although perfection in language can hardly be expected, yet there is a degree of excellence which is not so difficult of attainment as to render all exertion unavailing. There are thirty-eight elements in the English alphabet, and to represent these elements by appropriate characters, we should have thirty-eight letters. There is, then, a deficiency in our alphabet of twelve letters—and he who shall supply this imperfection, will be one of the greatest benefactors of the human race. This work must be done before our orthography can be rendered consistent, our pronunciation natural and uniform, and our language easy of acquisition. Until this is accomplished, words must be spelled one way, and pronounced another—indeed, two languages must be learned instead of one. Should the English language, as some confidently expect, become the language of the world, the advantages in which a complete alphabet would result, can be conceived by those only who have duly reflected upon the subject.

The term *El Dorado*, was not, however, originally used to designate any particular place: it signified generally "the gilded," or "golden," and was variously applied. According to some, it was first used to denote a religious ceremony of the natives, in covering the anointed body with gold dust. The whole of Guiana was, on account of the above usages, sometimes designated by the term *El Dorado*; but the locality of the fable which came to appropriate that name, was successively assigned to different quarters of that vast region, and the expeditions in search of it varied accordingly. The question, however, to be solved, is, whence arose the belief that a district so marvellously abundant with the precious metals existed in the interior of Guiana?—and the solution appears to have been left to Humboldt. While exploring the countries upon the Upper Orinoco, he was informed that the portion of Eastern Guiana lying between the rivers Essequibo and Branco is "the classical soil of the Dorado of Parima." In the islets and rocks of mica, slate, and talc which rise up within and around a lake adjoining the Parima river, reflecting from their shining surfaces the rays of an ardent sun, we have materials out of which to form that gorgeous capital, the temples and houses of which were overlaid with plates of beaten gold. With such elements to work upon, heated fancies aided by the imperfect vision of distant and dubious objects, might easily create that fabulous superstructure. We may judge of the brilliancy of these deceptive appearances from learning that the natives ascribed the lustre of the Magellanic clouds, or nebula of the southern hemisphere, to the bright reflections produced by them. There could not well be a more poetical exaggeration of the lustrous effects produced by the metallic hues of rocks of talc. These details, in which M. de Pons, a somewhat later traveller, who long resided in an official capacity in the neighbouring countries, fully concurs, in all probability point to the true origin of this remarkable fable. The well-known failure of Raleigh did not discourage other adventurers, who were found in quick succession; the last always flattering themselves with the hope that the discovery of *El Dorado* would ultimately be realised.

CHEMISTRY.

BY PROFESSOR SILLIMAN.

PART I.—PHYSICS.

INTRODUCTION.—1. Our knowledge of Nature begins with experience. While this teaches us that like causes, under similar circumstances, produce like effects, we also recognise as inseparable from our experience, the great principle that every event must have a cause. Man, “as the priest and interpreter of Nature,”* seeks to extend his experience by experiment. Every experiment is but a question addressed to Nature, asking for an increase of knowledge; and if we question her aright, we may be sure of a satisfactory answer.

2. *Observation* instructs us in a knowledge of the external forms of Nature, and we thus acquire our first impressions of the various departments of Natural History. Our knowledge would, however, be very limited, without a constant effort to extend our experience by experiment. The ancient Greeks and Romans were learned and polished in the intellectual arts, and excelled in many branches of human knowledge. Their ignorance, however, of the works of Nature, and the laws by which they are regulated, was extreme; and this was because they failed to question her aright: because they overlooked the true connection between cause and effect. The ancient philosophy abounded in plausible arguments regarding those phenomena of Nature which could not fail to arrest the attention of an intelligent people; but its reasonings were based on an *à priori* assumption of a cause, and not upon an inductive inquiry after facts and their connections. It failed to apply itself to the careful collection and study of facts *in order* to science. Facts in Nature are the expression of the Divine will, in the government of the physical world. The universe of matter is made up of facts, which, observed, traced out, and arranged, lead us to the knowledge of certain laws and forces which proceed directly from the mind of God. These are the “laws of

Nature;” science is but the exposition of them, and of science based upon such grounds, the ancient Philosophy was completely ignorant.

3. It is important to distinguish that knowledge which is purely intellectual in its character, from that which results from observation and experience. Speaking of this subject, one of the most learned of living philosophers says: “A clever man, shut up alone, and allowed unlimited time, might reason out for himself all the truths of mathematics, by proceeding from those simple notions of space and number, of which he cannot divest himself, without ceasing to think; but he could never tell, by any effort of reasoning, what would become of a lump of sugar, if immersed in water, or what impression would be produced on the eye, by mixing the colours yellow and blue.”—(*Herschel.*) We may, however, with propriety doubt, whether there is any knowledge or philosophy so purely intellectual, or absolute, that it does not imply some previous recognition of physical facts.

4. The physical philosopher is only of necessity an intellectual philosopher. The *observation* of facts forms only the foundation of science, and a fact isolated and unexplained has no scientific value. The knowledge of physical laws deduced from the study of observed facts will enable the philosopher to foretell the result of the possible combination of those laws, and to assign reasons for apparent departures from them. In this way discoveries are predicted and detailed; observation is anticipated, and called on to verify the alleged discovery. The perturbations of the planet Uranus indicated the existence of some body in space heretofore unknown. When Le Verrier had reconciled these disturbances with the supposed influence of a new planet, and determined its elements of motion, he had as truly discovered the remote sphere which now bears his name, as when the German astronomer, by pointing his telescope to the precise place in the heavens which Le Verrier had designated, announced to the world that the stupendous prediction was verified by observation. In like manner, a familiarity with chemical laws enables the chemist to foretell the result of combinations which he has

* “*Homo naturæ minister et interpres.*”—*Bacon.*

never investigated, and in some cases even to assign the constitution of bodies which he has never analyzed.

5. Our knowledge of Nature is conveniently classified under three great divisions, which are, Natural History, Mechanical Philosophy, and Chemistry. The first teaches us the characters and arrangement of the various forms of animal and vegetable life and minerals, giving origin to the sciences of Zoology, Botany, and Mineralogy. *Mechanical Philosophy* explains the laws which govern masses of matter, without considering of what that matter is composed. It tells us how bodies fall to the earth,—how liquids spout from an orifice; it explains the power of the lever, the screw, and the inclined plane; it teaches us the mechanical laws of the atmosphere and of the celestial bodies, the phenomena of tides and currents and the winds; but it tells us nothing of the nature of the various substances of which it treats.

Chemistry begins where the natural sciences end. It teaches us the intimate and invisible constitution of bodies, and reveals to us the compounds which may be formed by the union of simple substances, and the laws of their combination. It investigates the forces resident in matter, and which are inseparable from our idea of molecular action,—forces whose play produces the phenomena of Light, of Heat, and of Electricity. Chemistry also unfolds the wonderful operations of animal and vegetable life, so far as their functions depend upon chemical laws, as in the processes of respiration and digestion.

While we now direct our attention to Chemistry, we naturally inquire, What is Matter?

I. MATTER.

1. General Properties of Matter

6. *Experience*, founded on the evidence of our senses, has convinced us of the existence of matter. We feel the resistance which it offers to our touch; we see that it has form, and occupies space, and hence we say it has extent; and lastly, we attempt to raise it, and we find ourselves opposed by a certain force which we call weight.

Matter possesses extension, because it

occupies some space. It is impenetrable, because one particle of matter cannot occupy the same space with another at the same time. It has gravity, because it obeys the law of universal gravitation. Whatever, therefore, possesses these three qualities, is matter.

7. Let us look at these qualities a little more attentively. The largest and most solid masses of matter, even entire mountains, may be ground down by mechanical force to dust so fine that the winds will bear it away; but each minute particle still occupies some space, and we may imagine that a great multitude of smaller particles may still be formed from its further division. A grain of gold may be spread out so thin as to cover 600 square inches of surface on silver wire, and an ounce can in this manner be made to cover 1,300 miles of such wire. One grain of green vitriol (sulphate of iron), dissolved, and diffused in twenty million grains of water, will still be easily detected by the proper tests. The delicate perfume of musk, which is due to matter in an exceedingly fine state of division, has been known to remain for many years in a drawer or apartment, and still to emit very decided fragrance. Of course it had continued to give its appropriate odour during the whole time; and, being invisible at first, we may form some idea of the wonderful minuteness of each particle.

The organic world also presents us with beautiful examples of the great divisibility of matter, in the remarkable forms of animalcules revealed by the microscope, many millions of which can be embraced in a single drop of water. Yet each of these inconceivably minute organisms has its own muscular, digestive, and circulatory systems. How minute, then, the ultimate particles, of which many myriads must be contained in each animalcule!

It is, however, maintained that matter is not infinitely divisible; for none of the attributes of infinity can be predicated of that which is finite.

8. *Molecules, or Atoms*.—Every mass of matter, however minute, is composed of a vast number of extremely minute particles, which we call molecules,* or atoms.

* *Molecule*, a diminutive, from *moles*, a mass. This term is preferable to "atom" or "ultimate

Whatever size these particles may possess, they are the centres of all the forces or powers whose united effect gives matter all its known properties. We can, however, form some idea of the *relative* size and weight of these molecules, as is made evident by the laws of chemical combination; and the laws of crystallization also reveal the fact that they have an inherent difference of form, some being spherical while others are ellipsoidal.

We know that matter of all sorts is influenced by the laws of universal gravitation. It is the constant operation of this law on matter which gives it the property that we call weight, which is the measure of the force required to overcome the attraction of gravitation. This force, in the language of natural philosophy, is said to be directly as the quantity of matter, and inversely as the square of the distance. The weight of a body is therefore dependent on the number of molecules or atoms which it contains.

9. *Indestructibility of Matter*.—No particle or atom of matter can ever be annihilated or destroyed. The same Omnipotence which called it into being is required to destroy it. But, it may be asked, do we not see matter daily perishing before us in our fires, and vanishing in smoke and vapour? Its forms do indeed vanish from our sight, but it is not lost; and we shall learn, when we come to attend to the beautiful phenomena of life, by how Divine an arrangement the winds and the rains gather up their lost atoms, and restore them to the earth, thus clothing it with new beauty.

10. *Cohesion*.—The power of gravitation just mentioned, acts alike on all matter, and at all distances. But the power which holds together the several particles of matter which form a solid mass, acts on particles of a like kind, and at insensible distances. This attraction of aggregation is called the force of cohesion,—that power which we must overcome before we can reduce a piece of marble, or lead, to dust or smaller fragments. Opposed to this force, which would draw together and keep united all the particles of a body, we

have the power of *repulsion*, whose tendency is to separate these particles from one another.

In illustration of the first of these powers, if we press together two smooth surfaces of lead, clean and bright, as, for example, the halves of a bullet cut through, they will adhere or unite together so firmly as to require the power of several pounds weight to draw them apart. The plates of polished glass, also, which are prepared for large mirrors, if allowed to rest together, with their surfaces in close contact, have been known to unite so firmly as to break before they would yield to any effort to separate them. This is owing to the force of attraction between the particles of the same kind, called homogeneous attraction, or the attraction of aggregation.

11. *Repulsion*.—We see the second of these opposing powers, namely, repulsion, in one of the common effects of *HEAT*. This power is able to overcome the strongest attraction, and to separate to a great distance the particles before closely united. Heat will convert ice into water, and the water into invisible vapour. The most solid metals cannot resist its power; and yet, when it ceases to operate, the antagonist power of attraction again draws the separated particles together, and restores the original form.

12. *Chemical Attraction*.—Matter is, however, governed by another and yet more powerful force of attraction, namely, the power of *affinity* or *chemical attraction*. It is unlike the power of gravity, because it acts only at invisible distances, and is also unlike the power of cohesion (attraction of aggregation), because it exists only between particles of different kinds. Gravity acts on all matter, and at all distances. Cohesion acts only on the same kind of matter at insensible distances. Chemical affinity acts only between unlike particles at insensible distances.

13. The action of this marvellous power of chemical affinity, results in producing, from two unlike particles or atoms of matter, a third body having no resemblance, in any of its properties, to either of the other two constituent particles. The compound molecule of the new body acts the part of a simple molecule, in its relation to other bodies. To follow out

particle" as implying no theory, which both the others do. Atom is from *a* privative and *temno*, I cut, signifying their supposed indivisibility.

all the wonderful results of this power of affinity, and make ourselves acquainted with all the new bodies which are formed under its influence, constitutes the proper business of the chemist. To do this, we must first become familiar with a number of other important subjects.

14. *Elements*.—If we could imagine a world to exist, composed wholly of lead or of iron, and capable of supporting human life, it would afford no opportunity for the study of the science of chemistry, which owes its existence to the fact that matter is various and not simple. We learn not only that there are different kinds of matter in the world, but also that nearly all the forms in which we see it in Nature, or in which we make it combine by art, are capable of being reduced to a few simple substances, which are called *elements*. An element is a form of matter which has hitherto resisted all attempts to obtain from it anything more simple. The number of such bodies at present known is fifty-six, and of these all things are made. The progress of science may show us, by improved methods of investigation, that some of our elements are compounds, or, on the other hand, some new ones may be discovered. Water was one of the four elements of the ancients (earth, air, fire, and water). We now know that water is a compound of two gaseous elements (oxygen and hydrogen). Gold is an example of what we suppose to be an element. We can alter its form by combining it with other substances, thus making it part of a new compound, but no process has ever enabled us to show that it is itself a compound. The process by which a body is shown to be a compound is called *analysis*; and that by which the same body is reproduced, by the direct union of its elements, is called *synthesis*. Where these two modes of proof are united, the evidence obtained is of the very highest kind.

15. *Imponderable Agents*.—Besides the elementary matter of the world, of which we have already spoken, there are certain other agents of so subtle a nature that they possess none of the common properties of matter. These are Light, Heat, and Electricity; they are frequently called *imponderable* agents, because we have never been able to collect and weigh them. Of

their real nature, it must be remembered, we know nothing. We shall treat of them as if they were matter, because the language of science accords with this mode of presenting their phenomena. Late investigations countenance the opinion that they are inseparably connected with the existence of matter, and should be classed philosophically with its general powers of forces. Chemical affinity has been considered identical with electricity. It is also considered as an established fact in science, that there exists, throughout all space, an extremely rare elastic medium, called *ether*, whose vibrations cause the phenomena of light. Whatever may be the ultimate fate of this opinion, it is found to accord with the most mathematical exactness with all the phenomena of optics.

2. *The Three States of Matter—the Solid, Fluid, and Gaseous.*

16. The three common conditions, or states, in which matter is known to us, are the solid, fluid, and gaseous. Indeed we may reduce them simply to solids and fluids, if we choose to consider fluids as of two sorts, *elastic* fluids, as air and vapour, and *inelastic* fluids, as water and other liquids. We have already hinted that these several states of matter depend on the power of heat. (11). This cause will be more fully considered in the chapter on Heat.

17. *Properties of Solids*.—It is the distinguishing property of solids to have their particles bound together by so strong an attraction as in a great measure to destroy their power of moving among each other.

No solid, however, not even gold and platinum, which are the most compact solids known, has its particles of matter so aggregated as to be incapable of some condensation. Blows, pressure, or a reduction of temperature, will condense almost all solids into a smaller bulk, and water may even be forced through the pores of gold, by very great mechanical pressure. All solid bodies are, therefore, considered as porous, and their particles are believed to touch each other in comparatively few points.

18. Solids possess other several properties which may be considered in one way or

another as modifications of the power of *cohesion*. (10.) (1.) *Hardness*; this property is possessed by solids in very various degrees, from the diamond, the hardest of all substances, to those solids which are so soft as to be easily scratched by the finger-nail, as lead and some minerals. Hardness has no connection with weight or density, for lead is more than three times as heavy as the diamond. (2.) *Elasticity*; or, the power of assuming their original form after being bent or compressed. It is found in all degrees of perfection, from glass and steel, which are almost perfectly elastic, to lead, which possesses none of this quality. (3.) *Brittleness* is often closely connected with the last property. If glass or steel be bent beyond a certain degree, it breaks suddenly: this point is the limit of their elasticity. (4.) *Malleability*, or the capability of being beaten by blows into thin leaves, is found in the highest perfection in gold, and in a good degree in many other metals; 300,000 leaves of gold are but an inch thick; while an equal number of leaves of common letter paper would be several rods in thickness. (5.) *Ductility* and *laminability* are properties closely allied to malleability. Iron, for instance, unless heated, cannot be beaten like gold, but it may be drawn into fine iron wire (ductility) and plated by rollers into thin sheets (laminability.)

19. *Fluids*.—Fluids are distinguished from solids by the perfect freedom of motion among their particles. We have said (16) that fluids may be divided into two classes; liquids, like water, and gases or vapours, like air and steam. The first is inelastic, or very nearly so; the second highly elastic. We will consider them separately.

20. *Liquids* press with equal force on all parts of a vessel containing them. If an attempt be made to condense water, for instance, in a tight vessel, the pressure exerted for this purpose will at once be felt in every part of the fluid, and on all sides of the containing vessel to the same degree as on the portion where the power is applied. Liquids are said to be inelastic; but this is not strictly true, for water may be compressed, in the refined apparatus of Ærsted, one part in 22,000 for every atmosphere of pressure, and the water in a vessel sunk to the depth of

1,000 fathoms (6,000 feet) in the sea, has been compressed to nineteen-twentieths of its original bulk. For all practical purposes, however, water and other fluids are inelastic, so that they may be applied to exert immense power in the hydrostatic press.

21. *Capillary attraction* is a property possessed by fluids as distinguished from solids. By this property, fluids will mount in small tubes (called capillary or hair tubes, from the hair-like fineness of the bore) to a considerable height against the power of gravity. It is this power which enables wood and other porous bodies to draw up into their pores any fluid with which they may come in contact. Water standing in a tumbler has its surface made concave, being raised by capillary attraction at the edges where it comes into contact with the glass.

The capillary force is so great, that plugs of dry wood driven into holes bored for the purpose in rocks, and then saturated with water, swell so much from the quantity of water drawn into the pores of the wood (by capillary attraction), as to burst open the rocks. By the same power, a lamp or candle draws up its supply of fuel. A solid bar of lead, bent like the letter U, and one end of it put into a vessel of quicksilver (the only metal which is a fluid at common temperatures), after some time becomes so saturated with the mercury by capillary action, as to convey it out of the vessel, like a syphon.

When *surfaces are wet* by water or oil, or any other fluid, it is by virtue of this power; and we see from this that the capillary power is closely connected with chemical affinity (or heterogeneous attraction). Mercury, for instance, will not wet or cover the surface of glass or the skin, nor of iron; but it at once wets lead, tin, gold, silver, and many other metals. Glass can be wet by water only with some difficulty: oil, however, easily wets glass, and after this, water cannot be made to adhere to its surface at all.

22. The *cohesion* of the particles of a liquid for each other, is well shown by the globular form of the dew-drop; the power of cohesion (or *homogeneous attraction*) tending to bring all the particles to a centre, produces a sphere. A soap-bubble is a beautiful example of the cohesive

power of a thin film of liquid. Soap-water is more viscid, but not more coherent than pure water, and the bubble may be considered as a large drop of water, with all its interior removed, and the place supplied with air. The cohesive power of the particles of water in the film of the bubble is so great, that if the pipe be taken from the mouth before the bubble leaves it, a stream of air will be driven forcibly from the bore of the pipe, by the contraction of the film.

23. *Elastic fluids* are either gases or vapours. A gas is matter in a *permanently* ærial form. A vapour is matter *temporarily* in an ærial form. The same physical laws govern both, and we will briefly review them.

24. *The Atmosphere and Laws of Gases.*—We live on this planet at the bottom of a vast ocean of gaseous matter, which we call the air, or our atmosphere. It surrounds us everywhere, and presses upon us with a weight which, when stated in numbers, seems beyond belief. Under its influence, all operations, chemical as well as mechanical, are performed. It penetrates deeply into the crust of the earth itself, and is largely dissolved in all its waters. Its chemical composition will be discussed in its proper place, when we come to consider the properties of the two elements of which it is principally composed.

CRICKETS EATEN AS FOOD.—The whole neighbourhood (of the city of Utah) swarms with crickets of an enormous size, having a body as large as a mouse, and extraordinarily long legs, which enable them to leap inconceivable distances. The crickets are a serious nuisance, for the ground is alive with them; and they are not only destructive where they have their way, but the effluvium they emit is about as disgusting a sample of scent as any to be met with. Though they burrow in the earth, they spend almost all their time on the surface, and delight in climbing up tall grass and weeds, uttering a grinding chirp that sets one's teeth on edge. They constitute the principal food of the Utah Indians, who eat them raw and roasted, and also make a sort of paste or jam by broiling them.

METEOROLOGY.

INTRODUCTION.

1. METEOROLOGY is that branch of natural science which treats of the atmosphere and its phenomena. The subject may be properly divided into *six parts*.

2. Part I. THE ATMOSPHERE.

Part II. AERIAL PHENOMENA—comprehending Winds in general, Hurricanes, Tornadoes, and Water-spouts.

Part III. AQUEOUS PHENOMENA—including Rain, Fogs, Clouds, Dew, Hoar-frost and Snow, and Hail.

Part IV. ELECTRICAL PHENOMENA—comprising Atmospheric Electricity and Thunder-storms.

Part V. OPTICAL PHENOMENA—including the colour of the Atmosphere and Clouds, Rainbow, Mirage, Coronas, and Haloes.

Part VI. LUMINOUS PHENOMENA—embracing Meteorites, Shooting Stars and Meteoric Showers, and the Aurora Borealis.

1. OF THE ATMOSPHERE.

As the common properties of the air, viz., *weight*, *fluidity*, and *elasticity*, are supposed to be already known by all, we shall proceed at once to the discussion of the entire body of air, termed the atmosphere; and first of its pressure, which is ascertained by the barometer,—an instrument so called from the Greek words, *baros*, weight, and *metron*, measure.

Barometer.—This instrument is of the highest importance in Meteorology, and requires a minute description. It is thus constructed:—Into a glass tube, about three feet in length, open at one end and closed at the other, mercury is poured until it is full; the open end being now closed by the finger, or any other means, the tube is inverted, and the lower end immersed in a vessel of mercury. When beneath the surface of the fluid the end is unstopped, and the column of mercury within the tube then settles down, until its summit is about thirty inches above the level of that within the vessel. The space above the column in the tube is a void, and is called the *Torricellian vacuum*, from Torricelli, the name of the Italian philosopher, who first constructed this instrument.

The column of mercury within the tube

is supported above the level of that in the vessel, by the upward pressure of a column of the atmosphere, having the same base as itself.

It is manifest from the various observations of eminent scientific men, that the weight of the atmospheric column is equal to that of the mercurial column of the same base; and this weight can be estimated by the common rules of arithmetic.

Any increase in the density of the atmosphere will be denoted by an elevation of the mercury, and a decrease by its depression.

To secure a perfect instrument, it is essential that the mercury should be free from any solid impurities, else the summit of the column will either be above or below its proper level, according as the foreign matter, mixed with the mercury, is lighter or heavier than the fluid. This end is attained by straining the mercury through chamois leather. If it is amalgamated with zinc or lead, it is purified by washing it with acetic or sulphuric acid.

When the tube is filled, moisture and small bubbles of air are found adhering to its interior surface, and are also contained in the mercury. These, if not expelled, will ascend when the tube is inverted into the Torricellian vacuum, the moisture rising in vapour. By their united elastic force, the ascent of the barometric column will be checked whenever any increase in the density of the atmosphere tends to elevate it.

This source of error is removed by boiling the mercury in the tube. When all the air and vapour are expelled, the tube, if gently struck, will give forth a dry, metallic sound; but if a bubble of air remains, the sound will be dull and heavy. By connecting the open end of the tube with an air pump, during the process of boiling, Dr. Jackson, of Boston, has still more effectually removed this imperfection.

By these means, the air may perhaps be totally excluded, when the instrument is first constructed; but in the course of time, it will again insinuate itself between the glass and the mercurial column. To prevent this evil, Professor Daniell of King's College, London, welds to the open end of the glass tube a ring of platinum, which possesses a greater affinity for mercury than glass. The mercury

adheres closely to the platinum, like water, and the passage of air, according to all experiments, appears thus to be effectually prevented.

Since the constant changes in the weight of the atmosphere produce corresponding fluctuations in the height of the barometer, a scale is placed near the top of the tube, extending from twenty-seven to thirty-one inches, a space which includes, at the surface of the earth, all the fluctuations of the column. This scale is divided into tenths of an inch; but, as the variations of the barometer are exceedingly minute, a contrivance, called a vernier, is annexed, by which a change, to the extent of one five hundredth of an inch, can be easily measured.

As the surface of the mercury in the reservoir is raised by the descent of the column, and depressed by its elevation, any change in the height of the barometer cannot be accurately estimated while the scale remains in the same position, unless this surface is always brought to the same point, before taking an observation. The necessity of so doing will be obvious, from the following illustration.

Temperature. — Mercury dilates, for every degree Fahrenheit, about one ten-thousandth part of its bulk, taken at the freezing point. The expansion of the scale varies with the metal of which it is composed, but its amount is, usually, so small, that it may safely be neglected in the required correction. Hence the following practical rule has been adopted, for reducing any observed altitude of the barometer, to the corresponding altitude at the freezing point:—"Subtract the ten-thousandth part of the observed altitude, for every degree above the freezing point." Thus, if the barometer stands at 29 inches, and the thermometer at 52° , the required correction is $20 \times .0001 \times 29 = .058$. If the temperature is below 32° , the correction must be added. To facilitate these calculations, a thermometer is always attached to the barometer.

Capillarity. — By capillary attraction is understood, the force exerted by the interior surface of small tubes upon the fluids contained within them. When the fluid moistens the tube, it rises above its proper level; but when it does not, as in the case of mercury, it sinks below it.

From this cause, a depression, termed its capillarity, occurs in the barometer, the extent of which is dependent upon the size of the interior diameter of the tube, and a correction for this must be added to the apparent height, in order to obtain the true altitude. In tubes of a small bore, the error from this source is considerable; but when the diameter exceeds half an inch, it becomes so small, that it may safely be neglected. This will be rendered evident by the inspection of the following table, which gives the amount of depression for tubes of various sizes.

Diameter of tube. inches.	Depression. inches.
·10	·1403
·20	·0581
·40	·0153
·50	·0083

When the instrument is not stationary, but is carried from clime to clime, and to different heights above the sea-level, two other corrections are necessary; one for the varying force of gravity, in different latitudes, and the other for the change of pressure, which diminishes with every increase of altitude above the ocean.

Such is the barometer, an instrument of great practical use, and of the highest value in meteorological researches.

(To be continued.)

HINTS TO TEACHERS.

PERSONAL HABITS OF THE TEACHER.

THE importance of correct habits to any individual cannot be overrated. The influence of the teacher is so great upon the children under his care, either for good or evil, that it is of the utmost importance to them as well as to himself that his habits should be unexceptionable. It is the teacher's sphere to *improve* the community in which he moves, not only in learning, but in morals and manners; *in everything* that is "lovely and of good report." This he may do partly by precept,—but very much by example. *He teaches, wherever he is.* His manners, his appearance, his character, are all the subject of observation, and, to a great extent, of imitation, by the young in his district. He is observed not only in the school, but in the family, in the social gathering, and in the religious meeting. How desirable

then that he should be a *model* in all things!

Man has been said to be a "bundle of habits," and it has been as pithily remarked—"Happy is the man whose habits are his friends." It were well if all persons, before they become teachers, would attend carefully to the formation of their personal habits. This, unhappily, is not always done; and therefore I shall make no apology for introducing in this place some very plain remarks on what I deem the essentials among the habits of the teacher.

1. **NEATNESS.**—This implies cleanliness of the person. If some who assume to teach were not proverbial for their slovenliness, I would not dwell on this point. On this point, however, I must be allowed great plainness of speech, even at the expense of incurring the charge of excessive nicety; for it is by attending to a *few little things* that one becomes a strictly neat person. The morning ablution, should never be omitted, and the comb for the hair and brush for the clothes should always be called into requisition before the teacher presents himself to the family, or to his school. Every teacher would very much promote his own health by washing the whole surface of the body every morning in cold water. This is now done by very many of the most enlightened teachers, as well as others. When physiology is better understood, this practice will be far more general. To no class of persons is it more essential than to the teacher; for on account of his confinement, often in an unventilated room, with half a hundred children during the day, very much more is demanded of the exhalents in him than in others. His only safety is in a healthy action of the skin.

The teacher should be neat in his *dress*. I do not urge that his dress should be expensive. His income ordinarily will not admit of this. He may wear a very plain dress; nor should it be any way singular in its fashion. All I ask is, that his clothing should be in good taste, and *always clean*. A slovenly dress, covered with dust, or spotted with grease, is never so much out of its proper place, as when it clothes the teacher.

2. **ORDER.**—In this place I refer to that

system and regularity so desirable in every teacher. He should practise it in his room at his boarding-house. Everything should have its place. His books, his clothing, should all be arranged with regard to this principle. The same habit should go with him to the school-room. His desk there should be a pattern of orderly arrangement. Practising this himself, he may with propriety insist upon it in his pupils. It is of great moment to the teacher, that, when he demands order and arrangement among his pupils, they cannot appeal to any breach of it in his own practice.

3. *COURTESY*.—The teacher should ever be courteous, both in his language and in his manners. *Courtesy of language* may imply a freedom from all *coarseness*. There is a kind of communication, used among boatmen and hangers-on at tap-rooms, which should find no place in the teacher's vocabulary. All vulgar jesting, all *double-entendres*, all low allusions, should be for ever excluded from his mouth.

Speaking of the *language* of the teacher, I might urge also that it should be both *pure* and *accurate*. Pure, as distinguished from all those cant phrases and provincialisms which amuse the vulgar in certain localities; and accurate as to the terms used to express his meaning. As the *teacher teaches* in this, as in everything, by example as well as by precept, he should be very careful to acquire an unexceptionable use of our language, and never deviate from it in the hearing of his pupils or elsewhere.

There is a *courtesy of manner* also, which should characterise the teacher. This is not that ridiculous obsequiousness which some persons assume when they would gain the good opinion of others. It is true politeness. By politeness I do not mean any particular form of words, nor any prescribed or prescribable mode of action. It does not consist in *bowing* according to any approved plan, nor in a compliance simply with the formulas of etiquette in the fashionable world. True politeness is founded in benevolence. Its law is embodied in the golden rule of the Saviour:—"Whatsoever ye would that men should do unto you, do ye even so unto them." It is the exercise of real

kindness. It entertains a just regard for the feelings of others, and seeks to do for them what would make them really happy.

The teacher should possess this quality. Whenever he meets a child, it should be with the looks and words of kindness. Whenever he receives any token of regard from a pupil, he should acknowledge it in the true spirit of politeness. Whenever he meets a pupil in the street, or in a public place, he should cordially recognise him. In this way and a thousand others, which, if he have the right spirit, will cost him nothing, he will cultivate true courtesy in his pupils. He can do it in this way more effectually than he can by formally lecturing upon the subject. True politeness will always win its true reciprocation.

4. *PUNCTUALITY*.—This, as a *habit*, is essential to the teacher. He should be punctual in everything. He should always be present at or before the time for opening the school. A teacher who goes late to school once a week, or even once a month, cannot very well enforce the punctual attendance of his pupils. I once knew a man who for seven long years was never late at school a single minute, and seldom did he fail to reach his place more than five minutes before the time. I never knew but one such. I have known scores who were frequently tardy, and sometimes by the *space of a whole hour*!

A teacher should be as punctual in dismissing as in opening his school. I know that some make a virtue of keeping their schools beyond the regular hours. I have always considered this a very questionable virtue. If a teacher wishes to stay beyond his time, it should be either with delinquents, who have some lessons to make up, or with those who voluntarily remain. But, after all, if he has been strictly punctual to the hours assigned for his various duties in school, there will scarcely be the necessity for him or any of his pupils to remain beyond the time for dismissal; and, as a general rule, a regard both for his own health and theirs should forbid this. It is better to work diligently while one does work, and not to protract the time of labour, so as to destroy one's energy for to-morrow.

This habit of punctuality should run through everything. He should be punctual in all engagements; he should be studiously so in all the details of school exercises; he should be so at his meals, at his private studies, at his hour of retiring at night and of rising in the morning, and also at his exercise and recreation. This is necessary to a truly exemplary character, and it is equally as necessary to good health.

5. HABITS OF STUDY.—Unless the teacher takes care to furnish his own mind, he will soon find his present stock of knowledge, however liberal that may be, fading from his memory and becoming unavailable. To prevent this, and to keep along with every improvement, he should regularly pursue a course of study. I say *regularly*; for in order to accomplish anything really desirable, he must do something every day. By strict system in all his arrangements, he may find time to do it; and whenever I am told by a teacher that he *cannot find time* to study, I always infer that there is a want of order in his arrangements, or a want of punctuality in the observance of that order. Human life indeed is short; but most men still further abridge the period allotted to them by a disregard of system. No thing is more detrimental to health and happiness than disorder of any kind.

FORMATION OF HABITS.—Success in life depends, in a great measure, on the early formation of our habits. Whether our grand object be wealth or fame, or that nobler one, exalted virtue, we must shape our habits to that object, or we shall fail. What enabled Franklin to obtain the highest honours of philosophic fame; to stand, as he expresses it, “before kings,” and what is better, to live in the memory of his countrymen? The early formation of good habits. The perusal of his autobiography, which no young man should omit, will show what those habits were. What made Girard the richest citizen of America, and the benefactor of his race? The formation of early habits of frugality, disinterestedness, and self-denial. Such habits are not formed in a day, nor will they result from a few faint resolutions. They are the result of continued effort.

ROME AND ITS RULERS.

A SKETCH FOR THE YOUNG.

THE magnificent city of Rome was at first a rude hamlet of ruder people. Its earliest buildings were upon the Palatine Hill, near the Tiber. In process of time, it extended itself over the six adjacent eminences. Hence, the name that it sometimes bears of the “seven-hill’d city.”

Two brothers, Romulus and Remus, were its founders, 752 years before the birth of Christ. They were twins, and trained up in the humble and hardy habits of a shepherd’s life. But from feeding their peaceful flocks they aspired to rule men.

Romulus reared a wall around a portion of the new settlement, in which he took pride. Remus, in sport, or contempt, jumped over it, saying that he had given proof it would afford no protection against invaders. Romulus, forgetting the love he should have borne to his twin-brother, in a transport of rage, struck him dead upon the spot. Thus, to the first king of Rome, as to the first-born of Eden, might have been said, “The voice of thy brother’s blood crieth unto me from the ground.” He who gave his own name to the mistress of the world, left that name stained with the crime of fratricide.

Rome had the same number of kings as the hills on which she seated herself. The seventh, and last, was Tarquinius Superbus. After the abolition of the royal sway, she had various forms of government. At times her rulers bore the title of Consuls, Dictators, Tribunes, Ediles, and Questors. Then the supreme power was vested in Emperors, of whom there were fifty five. Some of these were fearful examples of every vice. The excess of luxurious indulgence and pitiless cruelty darken their names in history.

Among this mass of shameless rulers, five appeared, in regular succession, who by their comparatively virtuous course, have obtained the honourable distinction of the “good Emperors.” The first of this line was Nerva, who began his reign in the year 96, after the Christian era, when he was himself quite advanced in age. He was a native of Spain, and the first foreigner who had been permitted to wear Rome’s imperial purple. He was

welcomed with great joy, for the people had just been suffering from the monstrous barbarities of Domitian. Nerva was a man of gentle temper, and, like Numa Pompilius, the second king, who had reigned about eight centuries before him, a true lover of peace. With paternal care he used the public money for the public good, instead of wasting it in mad extravagance, like his predecessors. Unfortunately, his sway was short, only about sixteen months, when he fell a victim to a sudden fever, at the age of sixty-six. His memory was gratefully embalmed, for his justice and generosity, and the tranquillity he had given to the empire.

Trajan, his successor, was also born in Spain. In his youth he had been the pupil of Plutarch, the philosopher, who, after his elevation, thus addressed him in an affectionate epistle. "Continue the command of your passions. Make virtue the scope of all your actions. You have it in your power to render me the most honoured of men, by continuing your present course of conduct. If you follow my instructions, I shall glory in having given them. If you neglect them, this letter shall be my testimony, that you have not erred through the counsel or authority of Plutarch."

The Emperor did not disregard the motives set before him by his revered teacher. The principles that had been impressed on his boyhood were as a guiding helm amid the cares of state. He carefully improved his time, was moderate in expense, and modest amidst pomp and power. Among his public works was a noble bridge over the Danube, whose massy ruins are still seen by the traveller. He adorned the city of Rome with splendid and substantial buildings, and delighted to draw men of merit from obscurity. His faults were, too great fondness for war, and persecuting the Christians, which his strong attachment to the heathen ritual in which he had been educated, made him consider as a duty, or a proof of sincerity. He died, during an absence from home, of apoplexy, at the age of sixty-three, having reigned nineteen years.

Adrian, the fifteenth Roman emperor, began his reign in 117. He had received an excellent education. He was an elo-

quent speaker, and wrote well, both in prose and poetry. One of his greatest virtues was, that he truly loved peace. He treated those who were in humble stations with kindness. He said, that the chief ruler of a nation should be "like the sun, giving warmth to the lowly vales as well as to the mountains." He travelled to France, to Germany, and to Holland, not to make war, but to show himself friendly to their inhabitants. From thence he went to England, and built a wall from Cumberland to Northumberland, to assist in protecting that part of the island from the natives of the north, who were unfriendly and barbarous. He visited Spain and Athens, showing kindness to the people; and went also to many parts of Asia and Africa. He made just laws, and favoured men of learning. He had so remarkable a memory, that he could repeat the substance of a book after once reading it; and he knew the name of every soldier in the Roman army. Though he had so many virtues, he had also great faults. He committed some acts of cruelty, and was very unkind to the Jews. He banished them from their beloved city Jerusalem, and forbade them to come even in sight of it, or to enter it, except one day in the year. In his last sickness he became impatient of pain, and even entreated those around him to take away his life. He cried out, "How miserable a thing it is to seek death and not to find it!" Being a heathen, he had not the comfort of hope in another life. Just before he expired, he composed some verses addressed to his soul, expressing uncertainty with regard to its immortality. He died at the age of sixty-two, having reigned twenty-two years.

Titus Antoninus Pius was one of the most faultless of the good emperors. As his father died in his childhood, his mother and grandfather conducted his education. To them, as well as to all aged persons, he habitually paid great respect. In his youth, his temper was so mild and affectionate, that he gained the love of all with whom he associated. After he became emperor, he distributed among the poor the greater part of the revenue from his own estates. He completed a magnificent tomb for his predecessor Adrian, repaired many of the edifices of ancient

Greece, and built a wall in Britain, between the rivers Esk and Tweed. He laboured to prevent wars, and uttered the noble sentiment: "I had rather save the life of one citizen than destroy a thousand enemies."

He was friendly to the Christians, and showed them favour. He sought to be a peace-maker between all contending persons, and to set a consistent example of moral excellence. In these respects he has been compared both to Nerva and to Numa; the latter of whom preserved the blessings of peace to the people during his whole reign of forty-three years. Marcus Antoninus reigned somewhat more than half as long, viz., twenty-two years. During a residence at one of his country seats, he was attacked by a fever which proved fatal to him, at the age of seventy-four. He was loved and lamented by the whole empire, over which he had ruled as a father, seeking the welfare of his children.

Marcus Aurelius is a favourite with historians, and has been ranked among the greatest of the good emperors. He made his predecessor, who was his father-in-law, his model in the affairs of government. He took pleasure in praising his virtues, and thus affectionately mentions some of them, in a work of which he was the author:

"I have much observed his meekness and his constancy without wavering in those things which, after due deliberation, he had determined. I remember his freedom from all vanity, his patient industry, his readiness to hear any man that had aught to say tending to the common good. How readily and impartially would he give every man his due! How modestly would he condescend to other men, as though he was an ordinary man himself. How accurately would he examine and consult, and how patiently would he hear others! Neither would he hastily give over the search of difficult matters, or be easily satisfied with sudden notions and opinions. How carefully would he preserve his friends, never treating them with neglect, or growing weary of them! I love to remember his contented mind, his cheerful countenance, his care to foresee things afar off, and to give orders, without noise or clamour.

How was all flattery repressed by him, and how carefully did he observe all things necessary to the government, and keep an account of all the common expenses! And when he was reproached by some for this very strictness, how patiently did he bear it! He was neither studious to please men, nor ambitious of popular applause, but sober in all things, everywhere observant of that which was fitting. In those things which conduce to ease and convenience, of which his great fortune allowed him a plentiful supply, he was without pride or boasting. He freely enjoyed them when they were present, and when they were absent was never uneasy for the want of them. He was commended as a man that could not endure to be flattered, but was able to govern both himself and others. He honoured all true philosophers, without upbraiding those who were not so. In his conversation he was sociable and delightful. How gently would he yield to those who had any peculiar talent, such as eloquence, or knowledge of the laws, or ancient customs, and how heartily he endeavoured that every one might, according to their excellence, be regarded and esteemed! How constant was he in his attention to business, and after his great fits of headache, how fresh and vigorous would he return to his wonted affairs! In all things having respect unto men only as men, and to the equity of things, and not unto the glory that might follow."

Marcus Aurelius still further evinced his gratitude and reverence for Antoninus Pius by erecting to his memory a beautifully sculptured marble column, more than a hundred feet in height, and surmounted by his statue, which may still be seen at Rome, though more than 1,700 years old.

He was a lover of knowledge. Through his whole life he laboured to obtain it. After he became an emperor, he used to go, and sometimes on foot, to the house of a man of wisdom, named Apollonius, that he might take lessons of him. He valued intellectual riches more than gold or power. Among all the cares of state, he found time for it, saying that it was his desire to learn as long as he lived.

He was particularly attached to the study of philosophy, and used to call it

his mother, to prove his affection. He established schools for it, both at Rome and Athens. He often gave lectures in that science to the people, deeming it no derogation from imperial dignity, to instruct and elevate the public mind. Especially when about to be absent from the city for any length of time, he thus addressed his people, that if he never returned, their last remembrance of him might be connected with precepts of virtue.

His principal faults were, allowing the Christians to be persecuted, and being often engaged in war, though his principles revolted against it, and he considered it a calamity. He died at Vindebona, where the city of Vienna, in Austria, now stands, after the sickness of a week, on March 17th, 180; having lived fifty-nine years, and reigned nineteen. He was so much beloved that many kept his image or statue in their houses, offering it flowers and incense, as one of their heathen gods.

The two last of these emperors were called Antonines. Their united periods of sway amounted to forty-one years, and Rome never enjoyed greater happiness than during their sovereignty. Afterwards it declined both in prosperity and virtue.

UNIVERSITIES.—Had their first rise in the twelfth and thirteenth centuries. Those of Paris and Bologna are said to be the first that were set on foot; but then they were on a different footing from the universities among us. Our own universities of Oxford and Cambridge seem entitled to the greatest antiquity of any in the world; and Baliol and Merton colleges in Oxford, and St. Peter's in Cambridge, all made colleges in the thirteenth century, may be said to be the first regular endowments of this kind in Europe. For though University College in Cambridge had been a place for students ever since the year 872, yet this, like many of the other ancient colleges beyond sea, and Leyden to this day, was no proper college. Much are we indebted to these noble institutions, which have formed the intellectual characters of the greatest and wisest men in our country; and the venerable antiquity surrounding them gives them a higher claim to our regard.

RAIN WATER.

It is not generally known, says the *Albany Register*, that rain water, when protected from the atmosphere, is the purest, healthiest, and sweetest water in use. Mr. J. S. Van Rensselaer has for a great number of years used it for drinking and culinary purposes, and could never meet with any he considered as good. He was informed of its quality by a sea captain, who used it in his voyages from the United States to the West Indies, and who found that by carefully preserving it from exposure, casks which had been shipped at New York and made their outward voyage, were, on their return, found to be as pure and good as the day they were put on board.

Acting on this suggestion, he built two cisterns in his yard, covered, cemented and air-tight; one of which acted as a reservoir, communicating with the other, from which it was conducted into the dwelling. The cisterns were capable of holding seventy-five hogsheads; and, from the time of their erection, have always held a bountiful supply of pure, soft, and excellent water. The only communication with the air was by the pipe which conducted the water from the roof; every rain refreshed the supply, and as it was drawn from the bottom of the cistern, the temperature was cool and pleasant. Rain water is the purest in nature.

In this case it was conducted from a high slate roof, on which no dirt could accumulate, and the cisterns had required cleaning but once in six years, and then from no defect in the water. At no time has that been disturbed, or lost in the least its pure and wholesome taste; and that flat and rainy taste, so peculiar to it, when caught in open vessels, has never been noticed. It is strange that these simple and interesting facts are not more generally known and acted upon. The cost of cisterns is but a trifle, and we commend this cheap mode of obtaining pure water.

ADVERSITY. — Adversity exasperates fools, dejects cowards, draws out the faculties of the wise and industrious, puts the modest to the necessity of trying their skill, awes the opulent, and makes the idle industrious.



DROPPING-WELLS.

IF you journey through Yorkshire, be sure to stop opposite the ruins of Knaresborough Castle, because, on the south-west bank on the river Nidd, you will observe the petrifying spring of Knaresborough,—the celebrated dropping-well—where the peasants and the needy crowd to make their humble fortunes by afterwards retailing small sprigs of trees, such as the elder or ash, or pieces of the elegant geranium, the wild angelica, or the lovely violet, turned into “obdurate stone.” The petrifying properties of the dropping-well of Knaresborough, are generally well-known, and therefore we shall not enter into the detail of the various substances exposed to the influence of its wondrous waters.

It is well known that, as water passes over land in its course to a given place, certain principles are absorbed from the soil; and although the transparent fluid flows onward without betraying the minerals with which it is impregnated, yet its properties may be completely changed since its departure from the original source.

Every spring does not possess the petrifying properties of that of Knaresborough; but there are, doubtless, many dropping-wells distributed over the earth’s crust; and some of these are well known to possess the property of petrifying various objects submitted to the action of their waters. For example: we have seen birds’ nests, with the eggs, and delicate sprigs of moss surrounding them, and even the

fibres of wool turned into stone, aye, and delicate flowers. Whence is this extraordinary power derived? From the soil over which the waters flow! The limpid streams absorb the silicious particles, and deposit them in the intimate structure of the materials submitted to the action of the waters; and thus we find the materials of which the earth's crust is composed always undergoing a change.

Captain Skinner says, that at Sansad-hara, in India, which is known as the dripping-rock, there is a singular phenomenon situated at the head of a dell, through which a rapid stream runs, between two lines of hills towards the valley of the Dhoon. It is an overhanging rock, about fifty feet high, and the water pours from above, in innumerable little streams, like a perpetual shower of rain! The never-abating action of the water has worn the rock into many fantastic shapes; and, crusting round the moss and fibres of the roots of trees, has given to it almost the appearance of a spar cavern. In several places the water has worn little reservoirs for itself, which are always full. It is cool, clear, and pleasant to the taste.

Many springs of this character are to be met with in the neighbourhood of volcanoes; and even in the remote parts of our own land, uninfluenced by the convulsions of nature. They still drop the crystal and petrifying fluid through the projecting cliffs crowned with moss, grass, and the twining branches of parasitic plants. The peasant wends his way along the uncertain path, as unmindful of Nature's fearful changes around him as the team that precedes him, and even the setting sun imbuing the floating clouds with all the gorgeous hues of his ephemeral existence, are equally disregarded. Onward goes the peasant, unheeded passes the dropping-well, which trickles through the clefts amidst the massive rocks, and falling through the intermediate space, trickles its petriactive power on the surface below. Twenty gallons are poured forth every minute from the top of the Knaresborough cliff, and the beauty of the scene can only be appreciated by those who have stood upon the margin of those "stony waters" and beheld the crystal fluid descend from above with metallic fall.

THE REV. SAMUEL BENION.

A MODEL FOR TEACHERS.

THOSE are justly entitled to a high rank among the benefactors of mankind who have faithfully devoted themselves to the work of education. More than three centuries since, a far-sighted German wrote, "there is no more heavenly office than that of a schoolmaster."

Samuel Benion, who, both by native talent and voluntary choice, had a fitness for this elevated profession, was born in the county of Salop, June 14th, 1673. He was the eldest son of his parents, who were religious people of competent estate. He was early instructed at a grammar-school, and afterwards removed to the academy at Worksworth. There he became not only the favourite of his teachers, but of the neighbourhood, and it might almost be said, of the town also, so remarkable were his sweetness of temper, ingenuous manners, and readiness to oblige every person who came in his way, to the utmost of his power. His situation and studies were so delightful, and he so much pleased to remain, that he was permitted to prolong his stay beyond what was usual for youths of his proficiency. By continuing at the academy until his eighteenth year, he laid a broad and deep foundation for classic lore, and acquired the power of writing and speaking Latin with force and fluency. When his course was completed, his instructors parted from him with tears, regretting that their institution must sustain the loss of his example as a scholar and a Christian.

At his first departure from home for school, when very young, his parents were surprised and cheered by a paper left behind, in which he expresses gratitude for their kindness and care of his education, requests their prayers for him, and begs them not to fix their affections inordinately upon him, or in case of his sickness and death, mourn without hope, because he knew that whether living or dying, it would be well with him. Touching memorial of childhood's faith; and most precious to those tender, pious hearts, whose earnest prayer from his birth, had been, that he might live unto God.

He became a member of the University

of Glasgow, in Scotland, and such was the reputation he had already acquired for scholarship and high principle, that he was urged and persuaded to take two young gentlemen under his supervision. Here his application was incessant, and he frequently studied sixteen hours in a day, directing a little food to be brought to his room, that he might not be tempted to break in upon trains of thought by idle conversation at meals. His serious deportment, great diligence, and learning, caused him to be universally respected, and when he took his first degree, the Senate of the University honoured him with the office of President of all who were laureated that year, a dignity which had been seldom conferred upon any but natives of their own clime. At the time of his final graduation, the Regents courted his stay, promising him preferment. But neither ambition or gain could longer detain him from his loved home, where his coming was awaited with intense expectation, and his presence diffused serenity and joy.

However distinguished were his excellences as a scholar, they could not eclipse the beauty of his intercourse as a son and a brother. Every look, word, and action, expressed the respect and affection he bore to his parents, and toward his brothers and sisters, all of whom were younger than himself; there was a delicate mingling of tenderness with a guiding care.

It was his desire to have pursued his theological studies quite a length of time, enjoying and improving the home circle under his father's roof; but he was constantly importuned to assume the charge of a congregation in the vicinity, whose pastor had been recently removed by death. Being but twenty-three, retirement and longer preparation were far more consonant to his inclinations, and he said "he trembled at the thought of supplying the place of so great a man as the Rev. Philip Henry." When their solicitations finally overcame his reluctance, he selected, with an interesting numility, for the text of his first sermon, the expostulation of the prophet, "Ah, Lord God! behold I cannot speak—for I am a child!"

Yet, notwithstanding this lowly estima-

tion of himself, he supported the ministerial character with great propriety and dignity. His style of preaching attracted admiration, and he was earnest and successful in his parochial intercourse. His fluency of expression and suggestiveness of thought were conspicuous, as well as his solemnity in the administration of the ordinances. Every Sunday he catechised the children of his flock, and was happy in adapting his explanations, and winning their attention to the truths he taught. Such happiness flowed into his heart from these sacred, self-denying labours, that he would often say emphatically, that he "preferred the delight found in preaching and praying to all the entertainments and gratifications of sense."

Still he bore about him a meekness that nothing could disturb or inflate. It was not a mantle in which he sometimes wrapped himself, but a portion of his inner nature. When applauded for any performance, as he often was, he would reply with a child-like spirit, that "it might have been done better by himself, and far better by another person; and that he never left the pulpit without trembling to think how poorly he had discharged his duty."

Among the preferences of his boyhood had been a fondness for medical books. He liked to store his memory with their recipes, and was gratified to be invited to repeat or apply them. As he grew older, he gave attention both to the theory and practice of the science of healing, as he found he might thus be useful to the neighbouring poor. His reputation in this line became more extensive than he either anticipated or desired. Being on a visit at Glasgow, he was publicly examined in his knowledge of this profession by a convocation of the Heads of the College, who pronounced a high testimony of commendation, accompanied by the honorary degree of Doctor of Medicine. Some of the celebrated physicians of that day commended him, as "one of the most ingenious men with whom they had ever held consultation." Finding this occupation burdensome both to strength and time, he would gladly have withdrawn from it, but knew not how to withhold advice from the poor in their distress, and the friends who would consent to apply to no other phy-

sician. Precious opportunities were thus afforded of counselling and praying with them, for they could not in conscience refuse to listen to their benefactor, who gratuitously brought prescriptions and medicine for their sickness. Not satisfied to relieve the body's ills, and see the undying soul in danger, he became in a double sense "the beloved physician." This intimate knowledge of the condition and needs of those whom he served, taught him where he might, to the best advantage, distribute Bibles and other religious books, which he accompanied with an injunction that they should be carefully perused.

His benevolence also moved him to give a yearly salary to a competent and pious man for teaching the poor children in his neighbourhood to read, with a strict charge that none might know whence the annuity came. His ever-active benevolence rejected all ostentation. He also evinced a spirit of gentle forbearance towards all who differed from him in sentiment, and habitual care not to give offence to the feelings of the humblest of mankind.

At the age of thirty he married a lady of congenial tastes and endowments, whose piety and tender affection lent a new charm to his existence. Being established in a pleasant home of his own, he was strongly urged by friends who entertained a high opinion of his learning and peculiar tact in imparting it, to take charge of the education of their sons. After a proper season for deliberation, he yielded to their solicitations, and consented to assume the training of thirty students.

It was the opinion of many observers, that though his genius qualified him to excel in whatever he undertook, he had now found its native channel, in which he would attain a superiority before unequalled. Beside that love of teaching which is essential to a good teacher, his own protracted and thorough training in the languages and sciences, gave him facilities for imparting their rudiments, while the uncommon attachment which had subsisted between himself and his instructors, fitted him for that affectionate intercourse which changes toil to pleasure.

Nature had also given him external advantages for this noble profession, a countenance expressive both of gravity and

sweetness, and in his deportment a mixture of grace and dignity,—majesty tempered with mildness. His first appearance was prepossessing, and while a more intimate acquaintance developed qualities to conciliate love, nothing was revealed that could diminish respect. His clear and fine elocution heightened the effect of whatever he uttered, while his deep, classical knowledge, and philosophical mind, qualified him either to dictate or to argue with equal eloquence and force.

He lectured to his pupils in their several classes every day, and had the skill so to illumine and enliven abstruse subjects, that they all agreed, that though he might be sometimes long, he was never tedious. He occasionally discoursed extemporaneously, both in Latin and English, on various intricate points of philosophy, with such versatility of illustration and felicity of style, that they were considered not inferior to his more elaborate compositions. Anxious that his scholars should have the aid of the best guides, and not fully satisfied with the text-books in use, he took the trouble to prepare and simplify for them comprehensive systems of logic, metaphysics, mathematics, and ethics. In the department of pneumatics he was so lucid and ardent, that a contemporary biographer said, "his close application to the nature of spiritual essences might seem a presage of his own near approach to a world of spirits."

He was accustomed to recommend to his pupils the study of pure mathematics, as favourable to the virtues of patience and perseverance, and to mental stability and satisfaction, by rewarding labour with the certainty of demonstration. In comparing the different theories and hypotheses of philosophy, he taught them to guard freedom of thought, and search for truth without prejudice or partiality.

As in theology, he had formed his own opinions, not by a blind admission of the doctrines of any sect, but from the Scriptures, so he invited them to examine the expositions he gave them, and receive them only as far as they were consistent with the sacred text. Yet while he encouraged fair investigation, he zealously infused and fortified the first principles of religion, as an antidote to both scepticism and bigotry.

The government established over his students was strict and steady. His authority was founded on reason, reverence, and affection. He required diligence and subordination, resting his sway, as far as possible, on the heart. He enjoined that the early morning hours should be well improved, and nothing suffered to interfere with stated, secret devotion. Harmless recreations at proper intervals were indulged, while they were sedulously restrained from whatever was questionable or unbecoming. Whenever he perceived remissness in study, or carelessness in manner, or conversation, he gave admonition plainly, but tenderly. He had a peculiar tact in familiar conversation, of introducing subjects that might lead them, by their own remarks, to reprove themselves. Of this they were often so sensible, as to reform their own conduct, and save him the trouble of personal reproof. But where circumstances required admonition, he gave it firmly and solemnly, not in anger, but in love. He took pains to convince the delinquents that he delighted not in blame, but "as his beloved sons," he warned them. His expostulations often drew tears from hearts not apt to relent, while those that trembled in his own eye showed how truly he grieved for their faults. These interviews he closed with solemn prayer, and though young men of different habits, tempers, and pursuits, were submitted to his guidance, all were happily influenced, and some permanently impressed by his mode of treatment.

He was a shining, consistent example of the piety he strove to promote in them. His precepts had a stronger effect from their harmonizing influence on his life and conversation. He was skilful in extracting from common occurrences, a heavenly essence and spirit. In lecturing on the works of Nature, he ever directed the young mind to the great First Cause, as the object of adoration and love.

It was observed by those around him, that he appeared superior to casual disappointments and vexations. This self-control enabled him to control others. He seemed to them as one dwelling in a calm, undisturbed region, having his heart fixed on the "things unseen and eternal," of which he delighted to discourse. Those

who had no predilection for serious subjects, were induced to listen by his fatherly words—"My dear pupil, if anything I can say may be an instrument of advancing your good, or if I can do anything to promote your eternal welfare, how happy shall I be!"

Upon those who were designed for the ministry, he fervently laboured to impress the need of devout preparation, and the danger of unfaithfulness to souls. He encouraged them to thorough and careful study of the Scriptures in their original tongues. As they were in the habit of writing from memory his daily expositions, he accustomed them, once a-week, to read to him their separate transcripts, comparing them, and conversing seriously on the opinions they contained, that new ideas might be suggested, and the old more firmly fixed. Once a-week, each member of the theological class was required in his turn to analyze or explain a portion of Scripture, and offer the solemn service of prayer, ere they retired for the night. These exercises he deemed important, both to nourish their own personal piety, and to guide and give them readiness for their future work.

While he was thus deeply solicitous for their religious improvement and progress in the severer sciences, he was not neglectful of the refinements or graceful embellishments of education. Oratory and poetry received due attention, and in their written thoughts elegance of style was required, as well as clearness of argument. Fine elocution and correct emphasis were assiduously taught, and each pupil was called, at a stated time, to read aloud passages from different and difficult authors, that any defect in tone or utterance might be perceived and corrected.

The untiring efforts of this conscientious instructor were generally acknowledged and gratefully appreciated by his students. One of them, while still under his care, wrote home to his parents:—

"He so well understands the passions of the mind, and has so great an art in managing tempers, that he could, if he designed it, easily send out flaming bigots to almost any set of principles. But he is too much a Christian, a scholar, and a gentleman, to be swallowed up by the violence of any party. His aim is to

make men of sense and rational Christians; and if we fall short, it will not be his fault."

Constant prayer for Divine assistance gave him strength for his unresting and responsible station. In all his ways he acknowledged God, committing the minutest concerns to his guidance. Though his pupils, as a part of his family, had the privilege of joining in morning and evening worship, he deemed it a duty to begin and end their daily studies with prayer, saying that there were many petitions for them, in which the household had no part. When a new student entered, he commended him and his studies to the smile of an Almighty teacher; and when one returned home, he affectionately besought that the Divine blessing might go with him. If any of their number were sick, or in affliction, his tearful entreaties at the throne of grace revealed the solicitude and sympathy of a father.

Out of his large number of pupils three only died while under his care. Then he humbled himself, and bowed down as for a first-born. With floods of tears he said—"Let me resign myself, and all that is dear to me, into the hand of God. It is the Lord! Let Him do what seemeth Him good." Besides his public discourses on these occasions of bereavement, he gave most pathetic private ones to his pupils from Job: "He cometh forth like a flower, and is cut down." From Solomon: "Remember the days of darkness;" and from the reply of the mourning Shunammite: "It is well."

An address of his at their return from one of these obsequies, on the happiness of heaven, where parting and weeping are unknown, greatly affected his sorrowing and beloved pupils.

While thus active for the good of others, and in the prime of strength and usefulness, he became the victim of a fatal fever. The last evening of his life but one, as he sat in his chair, he seemed to doze; and suddenly awaking, spoke with animation of extraordinary music that had cheered him, more melodious and delightful than any he had ever heard or conceived. Was it a prelude of the celestial symphony he was so soon to join?

On the 4th of March, 1707, at the age of thirty-four, he was removed from earth.

Short was his term; yet he had accomplished more than many who reach the boundary of threescore and ten. What a scene of mourning did that desolate house present! An aged father and mother, who rested on him as the prop of their declining days; an affectionate wife, who had been united to him but a few years; two infant sons, unable to comprehend their loss; thirty pupils who loved him as their father; a family, deprived of its head; a flock without a shepherd. Few ever had more true tears shed at their death, and few have better deserved them. We cannot too strongly recommend a careful study of the character and life of this excellent man.

THE SEA A GREAT CEMETERY.—The sea is the largest of cemeteries, and its slumberers sleep without a monument. All other graveyards, in all other lands, show some symbol of distinction between the great and small, the rich and the poor; but in that ocean cemetery the king and the clown, the prince and the peasant, are alike undistinguished. The same wave rolls over all—the same requiem by the minstrelsy of the ocean is sung to their honour. Over their remains the same storm beats and the same sun shines; and there, unmarked, the weak and the powerful, the plumed and the unhonoured, will sleep on until awakened by the same trump when the sea will give up its dead. I thought of sailing over the slumbering but devoted Cookman, who, after his brief but brilliant career, perished in the President—over the laughter-loving Power, who went down in the same ill-fated vessel we may have passed. In that cemetery sleeps the accomplished and pious Fisher; but where he and thousands of others of the noble spirits of the earth lie no one but God knoweth. No marble rises to point out where their ashes are gathered, or where the lover of the good or wise can go and shed the tear of sympathy. Who can tell where lie the tens of thousands of Africa's sons who perished in the "middle passage?" Yet that cemetery hath the ornaments of Jehovah. Never can I forget my days and nights as I passed over the noblest of cemeteries without a single human monument.—R. T. S.

BOOKS AND WRITING OF THE GREEKS AND ROMANS.

BY CHARLES WILLIAMS.

THE books of the Greeks and Romans were written on long rolls of parchment, or sheets of papyrus connected by glue. This long roll of paper or parchment was fitted at each end to a wooden roller. The reader wound that part of the roll which he had perused on to the left-hand roller, and unrolled the next page from the right-hand roller, proceeding thus until he reached the end of the volume. The writing was arranged in lines which ran lengthwise along the roll, and were divided into columns or pages of a convenient width. The back of the roll was stained, usually of a saffron colour, and the volume provided with a yellow or purple parchment case. The ends of the rollers were often ornamented with carved bosses, and a label bearing the title was affixed to the roll. The ink for writing was similar to the Indian ink in use among ourselves, and was prepared either from lamp-black or the dye of the cuttle-fish. Red ink was also employed. The pen was formed from a reed, split and shaped much like our own quills. The booksellers in Rome were, of course, few when compared with the same class in a modern town; but their numbers were great, from the fact that they not only sold books, but also transcribed them. Both nations had their public and private libraries, and the value of some collections was immense. The books in a library were arranged in cedar-wood presses round the walls.

The ordinary apparatus for writing consisted of thin wooden tablets, overlaid on one side with a coat of wax, on which the letters were traced by indentation with a pointed metal pencil, or style. The waxen side of each tablet was furnished with a rim, to prevent the characters from rubbing. Two tablets, commonly, and sometimes three, were bound together so as to form a small book; and when three were united, the centre leaf had a layer of wax on both sides. The frames were pierced with holes, and when the letter or memorandum was finished, the adjacent edges of the closed tablets were bound together

by a thread passed through the holes, knotted and secured by a seal of simple wax. The signets used for impression were cut in various devices; and this engraving of gems is an art in which the Greeks and Romans excelled most highly. Some tablets have been discovered in which the writing ran from right to left. The custom of using wax tablets again appears in the middle ages.

In their contrivances for measuring time, the ancients were strikingly deficient. The length of their hours depended on that of the day, inasmuch as they divided the space between sunrise and sunset into twelve equal portions. Even their sundials were but imperfect; and the clepsydræ or hour-glasses, in which the flow of water, not of sand, was the measure of time, were very inaccurate, in spite of all improvements effected in them. They were at first constructed of bronze or earthenware, but afterwards of glass. Ctesibius, an Alexandrian mathematician, invented a kind of water-clock, B. C. 135, in which the dropping of water turned various wheels, and raised a small statue, which pointed to the hours. But the great element of inaccuracy, the unequal flow of the liquid, was manifestly present in this contrivance. Punctuality among the ancients must have been no more than a coincidence of guesses, and the consequences of this must have been serious in the ordinary affairs of life.

FRIAR BACON'S PROPHECY.—"Bridges," says he, "unsupported by arches, can be made to span the foaming current; man shall descend to the bottom of the ocean safely breathing, and treading with firm step on the golden sands never brightened by the light of day. Call but the secret powers of Sol and Luna into action, and behold a single steersman, sitting at the helm, guiding the vessel which divides the waves with greater rapidity than if she had been filled with a crew of mariners toiling at the oars. And the loaded chariot, no longer encumbered with the panting steeds, darts on its course with relentless force and rapidity. Let the pure and simple elements do thy labours; bind the eternal elements, and yoke them to the same plough."

NATURAL PHILOSOPHY.

CHAPTER III.

OBSERVATIONS ON NATURAL PHILOSOPHY.

(Continued from page 6.)

PNEUMATICS.—*General Relations of the Air—Its connection with Motion and Organization—Limited Extent—Constitution—Compressibility—Causes which Limit the Atmosphere—Its Variable Densities—Proportionality of its Elastic Force and Pressure.*

A very superficial knowledge of those parts of the world to which man has access, readily leads to their classification under three separate heads—the Air, the Sea, and the solid Earth. This was recognized in the infancy of science; for the four elements of antiquity were the divisions which we have mentioned, and Fire.

NATURAL PHILOSOPHY or PHYSICAL SCIENCE, which, in its extended acceptation, means the study of all the phenomena of the material world, may commence its investigations with any objects or any facts whatever. By pursuing these, in their consequences and connections, all the discoveries which the human mind has made in this department of knowledge might successively be brought forward. But when we are left to select at pleasure our point of commencement, it is best to follow the most natural and obvious course. All the advances made in our times by the most eminent philosophers, and our powers of appreciating and understanding them, depend on clearness of perception of the great fundamental facts of science—a perspicuity which can never arise from mere abstract reasonings or from the unaided operations of the human intellect, but which is the natural consequence of a familiarity with *absolute facts*. These serve us as our points of departure, and in the more difficult regions of science they are our points of reference—often by their resemblances, and even by their differences, making plain what would otherwise be incomprehensible, and spreading a light over what would otherwise be obscure.

In the three divisions of material objects, which are so strikingly marked out for us by Nature, we find traits that are eminently characteristic. All our ideas of permanence and duration have a convenient representation in the solid crust of the earth, the mountains, and valleys, and shores of which retain their position and features unaltered for centuries together. But the air is the very type and emblem of variety, and the direct or indirect source of almost every motion we see. It scarce ever presents to us, twice in succession, the same appearance; for the winds that are continually traversing it are, to a proverb, inconstant, and the clouds that float in it exhibit every possible colour and shape. It is, in reality, the grand origin or seat of all kinds of terrestrial motions. Storms in the sea are the consequences of storms in the air, and even the flowing of rivers is the result of changes that have transpired in the atmosphere.

But the interest connected with it is far from ending here. The atmosphere is the birthplace of all those numberless tribes of creation which constitute the vegetable and animal world. It is of materials obtained from it that plants form their different structures, and therefore from it that all animals indirectly derive their food. It is the nourisher and supporter of life, and in those processes of decay which are continually taking place during the existence of all animals, and which after death totally resolve their bodies into other forms, the air receives the products of those putrefactive changes, and stores them up for future use. And it is one of the most splendid discoveries of our times, that these very products which arise from the destruction of animals, are those which are used to support the life and develop the parts of plants. They pass, therefore, in a continual circle—now belonging to the vegetable, and now to the animal world; they come from the air, and to it they again are restored.

It is not, therefore, the beautiful blue colour which the air possesses, and which people commonly call the sky, or the points of light which seem to be in it at night, or the moving clouds which overshadow it and give it such varied and fantastic appearances, or even those more imposing relations which bring it in connection with the events of life and death, which alone invest it with a peculiar claim on the attention of the student. Connected as it is with the commonest of every-day facts, it furnishes us with some of our most appropriate illustrations—those simple facts of reference of which I have already spoken, and to which we involuntarily turn when we come to investigate the more difficult natural phenomena.

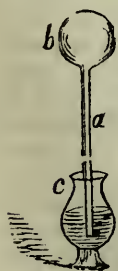
Astronomical considerations show that the atmosphere does not extend to an indefinite region, but surrounds the earth on all sides to an altitude of about fifty miles. Compared with the mass of the earth its volume is quite insignificant; for as it is nearly four thousand miles from the surface to the centre of the earth, the whole depth of the atmosphere is only about one-eightieth part of that distance. Upon a twelve-inch globe, if we were to place a representation of the atmosphere, it would have to be less than the tenth of an inch thick.

Seen in small masses, atmospheric air is quite colourless and perfectly transparent. Compared with water and solid substances, it is very light. Its parts move among one another with the utmost facility. Chemists have proved that it is not, as the ancients supposed, an elementary body, but a mixture of many other substances. It is enough at present for us to know that its leading constituents are two gases, which exist in it in fixed quantities—they are oxygen and nitrogen—but other essential ingredients are present in a less proportion, such as carbonic acid gas, and the vapour of water.

Atmospheric air is taken by natural philosophers as the type of all gaseous bodies, because it possesses their general properties in the utmost perfection. Individual gases have their special peculiarities—some, for example, are yellow, some green, some purple, and some red.

The first striking property of atmospheric air which we encounter, is the facility with which the volume of a given quantity of it can be changed. It is highly compressible and perfectly elastic. A quantity of it tied tightly up in a bladder or India-rubber bag, is easily forced, by the pressure of the hand, into a less space. The material properties of the air, and its compressibility, are simultaneously illustrated by the experiment of the diving-bell, described under *Fig 6*. A vessel forced with its mouth downward under water, permits the water to enter a little way, because the air contained in the vessel occupies less space under the pressure; but as soon as the vessel is again brought to the surface of the water, the air within it expands to its original bulk.

This ready compressibility and expansibility may be shown in many other ways.



Thus, if we take a glass tube, *Fig 10* with a bulb, *b*, at its upper end, the lower end being open and dipping into a vessel of water, *c*, and having previously partially filled the tube with water to the height, *a*, it will be found, on touching the bulb with snow, or by pouring on it ether, or by cooling it in any manner, that the included air collapses into a less bulk. It is therefore compressible, and on warming the bulb with the palm of the hand, the air is at once dilated.

It is this quality of easy expansibility and compressibility which distinguishes all gaseous substances from solids and liquids. It is true the same property exists in them, but then it is to a far less degree. On the hypothesis that material bodies are formed of particles which do not touch one another, but are maintained by attractive and repulsive forces at determinate distances, it would appear that, in a gas like atmospheric air, the repulsive quality predominates over the attractive; while in solids the attractive force is the most powerful, and in liquids the two are counterbalanced.

Again, as respects relative weight, the gases, as a tribe, are by far the lightest of bodies; and, indeed, it is among them that we find the lightest substance in Nature—hydrogen gas. They are, moreover, the only perfectly elastic substances that we

know. Thus, a quantity of atmospheric air compressed into a metal reservoir will regain its original volume the moment it has the opportunity, no matter how great may be the space of time since it was first shut up.

Under a relaxation of pressure this perfect elasticity displays itself in producing the expansion of a gas. If a bladder, partially full of atmospheric air, be placed under an air-pump receiver, as the pressure is removed it dilates to its full extent, and might even be burst by the elastic force of the air confined within. The force with which this expansion takes place is very well displayed by putting the bladder in a frame, as shown in *Fig. 12*, and loading it with heavy weights; as it expands by the spring of the air, it lifts up all the weights.

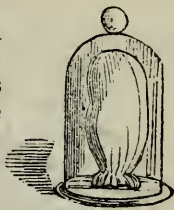


Fig. 11.

If we were to imagine a given volume of gas placed in an immense vacuum, or under such circumstances that no extraneous agency could act upon it, it is very clear that its expansion would be indefinitely great—the repulsive force of its own particles predominating over their attraction, and there being nothing to limit their retreat from one another. But when a gaseous mass surrounds a solid nucleus, the case is different—an expansion to a determinate and to a limited extent is the result. And these are the circumstances under which the earth and every planet surrounded by an elastic atmosphere exists; for in the same way that our globe compels an unsupported body to fall to its surface, and makes projectiles as bomb-shells and cannon-shot—no matter what may have been the velocity with which they were urged—return to the ground, so the same attractive force restrains the indefinite expansion of the air, and keeps the atmosphere, instead of diffusing away into empty space, imprisoned all round.

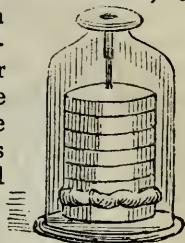


Fig. 12.

Besides this cause, gravitation to the earth, a second one, for the limited extent of the atmosphere, may also be assigned—contraction, arising from cold. Observation has shown that, as we rise to greater altitudes in the air, the cold continually increases; and gases, in common with all other forms of body, are condensed by cold. The attempt at unlimited expansion which the atmosphere, by reason of its gaseous constitution exerts, is, therefore, kept in bounds by two causes—the attractive force of the earth and cold—and accordingly its altitude does not exceed fifty miles.

From the circumstance that air is thus a compressible body, we might predict one of the leading facts respecting the constitution of the atmosphere—it is of unequal densities at different heights. Those portions of it which are down below have to bear the weight of the whole superincumbent mass; but this weight necessarily becomes less and less as we advance to regions which are higher and higher; for in those places, as there is less air to press, the pressure must be less. And all this is verified by observation. The portions which rest on the ground are of the greatest density, and the density steadily diminishes as we rise. [These facts may be illustrated by the following simple experiment. Take four bags of wool and place them one above the other. It will then be evident that the lowest bag is compressed by the other three above it, while the bag that is placed upon the top is entirely uncompressed. Now it is thus with the particles of which the air is composed, for we find that at the earth's surface the air is denser than on the top of a mountain.—W.T.K.] Moreover, a little consideration will assure us that there is a very simple relation between the pressure which the air exerts and its elastic force. Consider the condition of things in the air immediately around us: if its elastic force were less, the weight of the superincumbent mass would crush it in; if greater, the pressure could no longer restrain it, and it would expand. It follows, therefore, in the necessity of the case, that the elastic force of any gas is neither greater nor less, but precisely equal to the pressure which is upon it.

CHAPTER IV.

WEIGHT AND PRESSURE OF THE AIR.

Description of the Air-pump—Its Action—Limited Exhaustion—Fundamental fact that Air has weight—Relative weight of other Gases—Weight gives rise to pressure—Experiments illustrating the Pressure of the Air.

In the year 1560, Otto Guericke, a German, invented the air-pump, and exhibited a number of very striking experiments before the Emperor Ferdinand III. This incident forms an epoch in physical science.

Otto Guericke's instrument was imperfect in construction and difficult of management. The apparatus required to be kept under water. More convenient machines have therefore been devised. The following is a description of one of the most simple:—Upon a metallic basis, *h h*, Fig. 13, are fastened two exhausting-syringes, *a a*, which are worked by means of a handle, *b*, the two screw columns, *e e*, aided by the cross piece, *f f*, tightly compressing them into their places. A jar, *c*, called a receiver, the mouth of which is carefully ground true, is placed on the plate of the pump, *h h*, which is formed of a piece of metal or glass ground quite flat. This pump-plate is perforated in its centre, from which air-tight passages lead to the bottom of each syringe, and when the handle, *b*, is moved, the syringes withdraw the air from the interior of the jar. From the same central perforation there is a third passage, which can be opened or closed by the screw at *g*, so that when the experiments are over, by opening it, the air

Fig. 13.

can be readmitted into the interior of the receiver.

So far as its exterior parts are concerned, this air-pump consists of a pair of syringes worked by a handle, and producing exhaustion of the interior of a jar, with a vent which can be closed or opened for the readmission of air.

The syringes are constructed exactly alike. The glass model, represented in Fig. 14, exhibits their interior; each consists of a cylinder, *a a*, the interior of which is made perfectly true, so that a piston, *p*, introduced at the top may be pushed to the bottom, and, indeed, work up and down without any leakage. There is a hole made through the piston, *p*, and over it a valve is laid. This consists of a flexible piece of membrane,—as leather, silk, &c.,—which being placed on the aperture, opens in one direction and closes in the other. Such a valve is in the piston, and there is another one, *c*, resting on an aperture in the bottom of the cylinder.

Fig. 14.

To understand the action of this instrument, let us suppose a glass globe, full of atmospheric air, to be fastened air-tight to the bottom of such a syringe, and the piston then lifted to the top of the cylinder. As it moves without leakage, it would

evidently leave a vacuum below it were it not that the air in the globe, exerting its elastic force, pushes up the valve, *c*, and expands into the cylinder. In this way, therefore, by the upward movement of the piston, a certain quantity of air comes out of the globe and fills the cylinder. The piston is now depressed: the moment it

begins to descend, the valve, *c*, which leads into the globe shuts; and now as the piston comes down it condenses the air below it, and as this air is condensed, it resists exerting its elastic force. The piston-valve, *p*, under these circumstances, is pushed open, and the compressed air gets away into the atmosphere. As soon as the piston has reached the bottom of the cylinder, all the air has escaped, and the process is repeated precisely as before. The action in the syringe is, therefore, to draw out from the globe a certain quantity of air at each upward movement, and expel this quantity into the air at each downward movement.

For reasons connected with the great pressure of the air, and also for expediting the process of exhaustion, two syringes are commonly used. To their pistons are attached rods which terminate in racks, *b b*; between these is placed a toothed wheel, which is turned on its axis by the handle, its teeth taking into the teeth of the racks. When the handle is set in motion and the wheel made to revolve, it raises one of the pistons, and at the same time depresses the other. The ends of these racks are seen in Fig. 14. The wheel is included in the transverse wooden bar, *ff*, Fig. 13.

By the aid of this invaluable machine numerous striking and important experiments may be made.

The form described here is one of the most simple, and by no means the most perfect. For the higher purposes of science, more complicated instruments have been contrived, in which, with the utmost perfection of workmanship, the valves are made to open by the movements of the pump itself, and do not require to be lifted by the elastic force of the air. In such pumps, a far higher degree of rarefaction can be obtained.

No air-pump, no matter how perfect it may be, can ever make a perfect vacuum, or withdraw all the air from its receiver. The removal of the air depends on the expansion of what is left behind and there must always be that residue remaining which has forced out the portion last removed by the action of the syringes.

The fundamental fact in the science of Pneumatics is, *that atmospheric air is a heavy body*, and this may be proved in a very satisfactory manner by the aid of the pump. Let there be a glass flask, *a*, Fig. 15, the mouth of which is closed with a stop-cock, through which the air can be removed. If from this flask we exhaust all the air, and then equipoise it with weights at a balance, as soon as the stop-cock is opened and the air allowed to rush in, the flask preponderates. By adding weights

in the opposite scale, we can determine how much it requires to bring the balance back to equilibrio, and therefore what is the weight of a volume of air equal to the capacity of the flask.

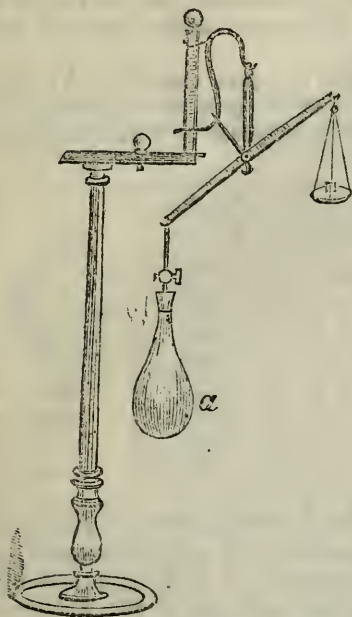


Fig. 15.

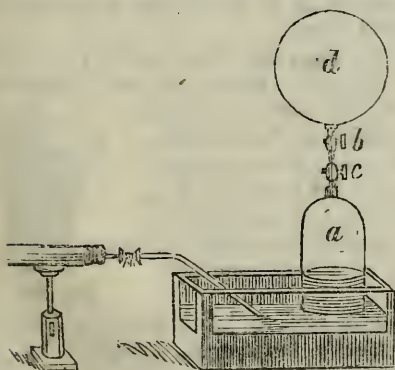


Fig. 16.

Upon the same principles we can prove that all gases, as well as atmospheric air, have weight. It is only requisite to take the exhausted flask, and having counterpoised it as before, screw it on to the top of a jar, *a*, Fig. 16, containing the gas to be tried. On opening the stop-cocks, *b c*, the gas flows out of the jar and fills the flask, which, being removed, may be again counterpoised at the balance, and the weight of the gas filling it determined. There are very great differences among gases in this respect.

[The following Table will show the respective weights of equal quantities by measure of several elastic fluids, including those which are of the greatest importance on account of their frequent occurrence, and the valuable purposes to which they have been applied:

	Weight of 100 cubic inches.	Specific Gravity.
Atmospheric air	30· 5 grains.	1·
Oxygen gas	33· 8 "	1·111
Nitrogen gas	29·25 "	0·972
Nitrous oxide.....	46· 6 "	1·527
Hydrogen gas.....	2·12 "	0·069
Carbonic acid	46· 5 "	1·529
Chlorine gas	76· 3 "	2·500
Sub-carburetted hydrogen ...	16· 9 "	0·555
Carburetted hydrogen	29· 6 "	0·972
Steam	18· 8 "	0·519

(Moffatt's "Boy's Book of Science," p. 192.)

The specific gravity of the atmosphere being the standard with which the density of all gaseous substances is compared, it is considered as unity. "At 30 Bar. and 32°, it is 769·4 times lighter than water, and 10,462 than mercury: or at 62°, 815 times lighter than water, and 11,065 times lighter than mercury. The knowledge of its exact weight is an essential element in many physical and chemical researches, and has been determined with very great care by Prout, who finds that 100 cubic inches of pure and dry atmospheric air at 60° and 30 Bar. weigh 31·0117 grains.—Turner's "Elements of Chemistry," page 263.

From the fact that the air has weight, it necessarily follows that it exerts pressure on all those portions that are in the lower regions, having to sustain the weight of the masses above. And not only does this hold good as respects the aerial strata themselves, it also holds for all objects immersed in the air. In most cases, the resulting pressure is not detected, because it takes effect equally in all directions, and pressures that are equal and opposite mutually neutralize each other.

But when by the air-pump we remove the pressure from one side of a body, and still allow it to be exerted on the other, we see at once abundant evidence of the intensity of this force. Thus, if we take a jar, Fig. 17, open at both ends, and having placed it on the pump-plate, lay the palm of the hand on the mouth of it: on exhausting the air, the hand is pressed in firm contact with the jar, so that it cannot be lifted without the exertion of a very considerable force.



Fig. 17.



Fig. 18.

In the same way, if we tie over a jar a piece of bladder, and allow it to dry, it assumes, of course, a perfectly horizontal position; but on exhausting the air within very slightly, it becomes deeply depressed, and is soon burst inward with a loud explosion. This simple instance illustrates, in a very satisfactory way, the mode in which the pressure of the air is thus rendered obvious; for so long as the jar was not exhausted, and had air in its interior, the downward pressure of the atmosphere could not force the bladder inward, nor disturb its position

in any manner: for any such disturbance to take place, the pressure must overcome the elastic force of the air within, which resists it, pressing equally in the opposite way. But on the removal of the air from the interior, the pressure above is no longer antagonized, and it takes effect at once by crushing the bladder.

CHAPTER V.

THE PRESSURE OF THE AIR.

The Magdeburgh Hemispheres—Water supported by Air—The Pneumatic Trough—Description of the Barometer—Cause of its Action—Different kinds of Barometers—Measurement of Accessible Heights.



Fig. 19.

MANY beautiful experiments establish the fact that the atmosphere presses, not only in the downward direction, but also in every other way. Thus, if we take a pair of hollow brass hemispheres, *a b*, Fig. 19, which fit together without leakage, by means of a flange, and exhaust the air from their interior through a stop-cock affixed to one of them, it will be found that they cannot be pulled apart, except by the exertion of a very great force. [In order to make the contact more perfect, the edges of the hemispheres are rubbed with grease previous to the air being exhausted.—W. T. K.] Now it does not matter whether the handles of these hemispheres are held in the position represented in the figure, or turned a quarter way round, or set at any angle to the horizon, they adhere with equal force together; and the same power which is required to pull them asunder in the vertical direction, must also be exerted in all others. This, therefore, proves that the pressure of the air takes effect equally in every direction, whether upward, or downward, or laterally.

[This experiment merits recollection, because it was one of the first which drew attention to the material nature and properties of the air, and it astonished the world. Otto de Guericke, of Magdeburgh, the inventor, had hemispheres made a foot in diameter; and once when he exhausted them, on the occasion of a public exhibition, six coach-horses of the Emperor were unable to pull them asunder.—*Arnott's "Elements of Physics, 3rd Edition, p. 321."*

Two small hemispheres of copper were exhausted and placed between four strong dray-horses; but they could not separate them although dragging in opposite directions for about half an hour.—W. T. K.]

Take a wine-glass, and having filled it entirely with water, place over its mouth a slip of writing-paper. If the wine-glass be inverted, it will be seen that the fluid is supported, the paper neither dropping off nor the water flowing out. This remarkable result illustrates the doctrine of the upward pressure of the air. Nor does it even



Fig. 20.

require that a piece of paper should be used, provided the glass has the proper form. Thus, let there be a bottle, *a*, Fig. 20, in the bottom of which there is a large aperture, *b*. If the bottle be filled with water, and its mouth closed by the finger, the water will not flow out, but remain suspended. And that this result is due to the upward pressure of the air is proved by moving the finger a little on one side, so as to let the air exert its pressure on the top as well as the bottom of the water, which immediately flows out.

If we take a jar, *a*, Fig. 21, and having filled it full of water, invert it, as is represented, in a reservoir, or trough; for the reason explained in reference to Fig. 19, the water will remain suspended in the jar. Such an arrangement forms the pneumatic trough of chemists. It enables them to collect the various gases without intermixture with atmospheric air; for if a pipe, or tube, through which such a gas is coming be depressed beneath the mouth of the jar *a*, so that the bubbles may rise into the jar, they will displace the water, and be collected in the upper part without any admixture.

If in this experiment we use mercury instead of water, the same phenomenon ensues—the mercury being supported by the pressure of the air. Now it might be inquired, as the atmosphere only extends to a certain altitude, and therefore presses with a weight which, though great, must necessarily be limited, whether that pressure could sustain a column of mercury of an unlimited length? If we take a jar a yard in length, and fill it with mercury, and invert it in a trough, it will be seen that the mercury is not supported, but that it settles from the top and descends until it reaches a point which is about thirty inches above the level of the mercury in the trough. Of course, as nothing has been admitted, there must be a vacant space or vacuum between the top of the mercury and the top of the jar.

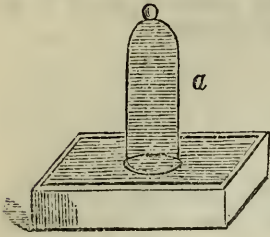


Fig. 21.

This experiment, which, as we are soon to see, is a very important one, is commonly made with a tube, *a, b*, Fig. 22, instead of a jar—the tube being more manageable, and containing less mercury. It should be at least thirty-two inches long, and being filled with quicksilver, may be inverted in a shallow dish containing the same metal, *c*. It is convenient to place at one side of the tube a scale, *d*, divided into inches, these inches being counted from the level of the mercury in the dish, *c*. Such an instrument is called a Barometer, or measurer of the pressure of the air.



Fig. 22.

Let us briefly investigate the agencies which operate in the case of this instrument. If, having closed the mouth of the tube, *b*, with the finger, we lift it out of the dish, *c*, it will be found that we must exert a considerable degree of force in order to sustain the column of mercury, which presses against the finger with its whole weight, and tends to push it away. Consequently, the mercury is continually exerting a tendency to flow out, and therefore two forces are in operation; on the one hand, the weight of the mercury attempting to flow out of the tube into the dish; and on the other, the weight or pressure of the atmosphere attempting to push the mercury up in the tube. If the pressure of the air were greater, it would push the mercury higher; if less, the mercury would flow out to a corresponding extent. Thus, the length of the mercurial column equilibrates the pressure of the air, and we therefore say that the atmospheric pressure is equal to so many inches of mercury.



Fig. 23.

That the whole thing depends on the pressure of the air may be beautifully proved by putting the barometer under a tall air-pump receiver, as represented in Fig. 23, and exhausting. As the pressure of the air is reduced, the mercurial column falls; and if it were possible to make a perfect vacuum by such means, the mercury would sink in the tube to its level in the dish. On re-admitting the air the mercury rises again, and when the original pressure is regained it stands at the original level.

There are many different forms of barometers, such as the straight, the syphon, &c., but the principle of all is the same. The scale must uniformly commence at the level of the mercury in the reservoir. Now it is plain that this level changes with the height of the column; for if the metal flows out of the tube it raises the level in the reservoir, and *vice versa*. In every perfect barometer, means, therefore, should be had to adjust the beginning of the scale to the level for the time being. In some barometers, as in that represented in Fig. 24, this is done by having the mercury



Fig. 24.

in a cistern with a moveable bottom, and by turning the screw *V*, the level can be precisely adjusted to that of the ivory point, *a*.

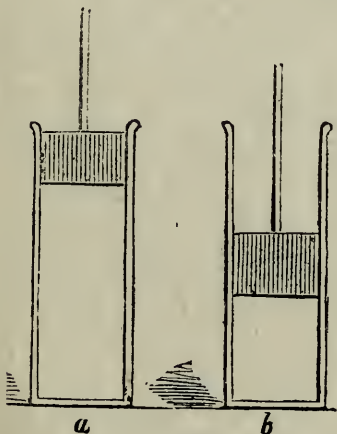
(To be continued.)

CHEMISTRY.

(Continued from page 16.)

25. It is usual to speak of a vessel or apartment which contains air only, as empty. It is easy to show, however, that the so-called empty space is in reality full, and that the matter it contains is just as capable of being weighed, transferred, and rendered sensible by its resistance to other bodies, as any other form of matter. If we plunge a bell-glass or inverted tumbler into water, holding its mouth horizontally downwards, we shall find a resistance to its descent, which arises from the air confined within it. The water will rise in the vessel to a certain height, which varies with the degree of pressure we apply. The deeper we sink the glass, the higher will the water rise in its interior, and the less space will the air occupy: as we diminish the pressure, the air, by its elasticity, returns to its former dimensions, and entirely displaces the water.

26. *Elasticity of the Air.*—Suppose the two tight-bottomed hollow cylinders *a* and *b*, in the annexed figure, to be filled with



air: if we fit a plug so tightly to the sides of both, that no air can pass between it and the sides of the cylinder, and then try to force down this plug by pressure on the stem, we shall find a resistance to its downward motion. The plug, or piston, as it is called, descends indeed, but with in-

creasing resistance as it goes down; and if the pressure be removed, it returns to its former position, suddenly and with force. We have thus demonstrated not only that the air is a material substance, offering resistance, but also, that it is an elastic substance, capable of compression to an indefinite extent, and of restoration to its former condition on the withdrawal of the pressure.

27. The elasticity of the air may also be shown by placing the piston in *b*, in the position represented in the drawing, the air beneath it being in the same state of pressure as that above; if we now attempt to raise the piston, the air which before filled only one-half of the cylinder, will expand and fill the whole; and this would be the case, if at the commencement of the experiment only one-thousandth part of the vessel contained air. The *tension* of the expanded portion, as it is termed, would then be only one-thousandth part of ordinary air at the earth's surface. We thus learn that air, and also many other gases, are perfectly elastic; although, as we shall see further on, there are a number of gases which can, by great cold and pressure, be reduced to liquids, and some of them even to a solid form.

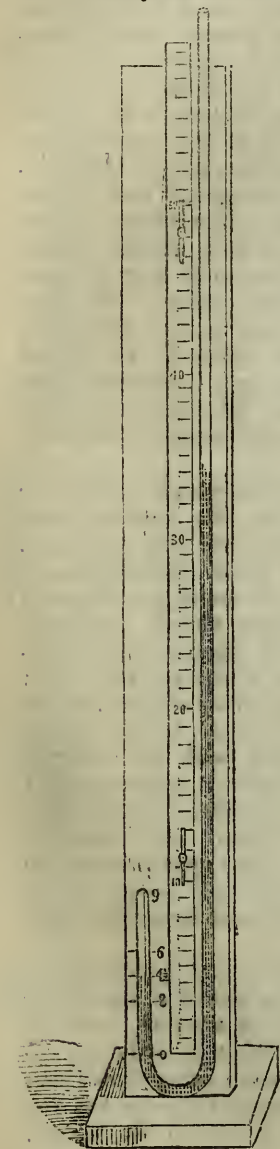
28. *Air-Pump.*—The remarks just made serve also to explain the principle and construction of the common air-pump, an instrument of great importance to science. In order to make an air-pump of one of the cylinders already described, it is necessary only to open a communication in the bottom of the cylinder with some vessel from which we wish to remove the air, and also to open a hole in the piston communicating with the external air. Each of the holes is covered with a little flap or lid of leather or oiled silk, fitting the orifice closely, and called a *valve*. Both these valves open freely in an upward direction, but the lower one is tightly closed by the least downward pressure.

29. *Vacuum.*—The space produced by exhausting the air is called a *vacuum*, or empty space; a perfect vacuum, however, cannot be formed in this way, although the air-pump can produce an exhaustion which answers all the purposes of science and art. Many forms of the air-pump are in use, all, however, depending upon the prin-

ciples explained. One of the most common is that in which two pistons are so arranged (see fig. in section 26) as to work up and down alternately, being moved by a winch and toothed wheel. Sometimes the cylinders are formed of heavy glass tubes, which enable the student to see the manner in which the piston and valves move, and better to understand the operation. The air-pump depends entirely on the elasticity of the air for its successful operation.

30. *Law of Mariotte.*—The volume or bulk

of air, at a given temperature, depends on the pressure to which it is subject, or in other words, *the volume of the air is always inversely as the pressure, while the density is directly as the pressure.* This is called the law of Mariotte, who was the first accurately to demonstrate it by experiments. The annexed figure shows the simple apparatus used by him for this purpose. It is a glass tube turned up and sealed at the lower end: a graduated scale of equal parts is attached to it. Mercury is poured into the open end of this tube so as to rise just to the first horizontal line, and a portion of air of the ordinary elasticity is thus enclosed in the short limb of 9 inches. Now if mercury be poured into the longer



leg, so that it may stand at 30 inches (33)

above the level of the mercury in the shorter leg, it will press with its whole weight on the included air, which will then be found to occupy $4\frac{1}{2}$ inches, only half of its former space. If, in like manner, the column of mercury be increased to twice this length, its pressure on the included air will be tripled, and the space occupied by it will be reduced to one-third, and so on in simple proportion.

31. *Weight of the Atmosphere.*—It has been abundantly shown by the experiments already explained, that the air has weight. The first movement of the air-pump will fix the air-glass on the plate of the pump, and after a tolerable exhaustion is produced, great force will be required to remove the jar, and the pump itself may often be lifted by it. The power that holds the air-jar down is only the weight of the air pressing upon the upper side of the glass, while that pressure is removed from the inside of the glass by the action of the pump; an upward pressure is also exerted upon the under side of the board or plate of the pump, thus co-operating with the downward pressure upon the glass receiver. The leather by which boys raise large stones and bricks acts in the same way. The leather adheres to the stone only because the air is pressed out from the surfaces of contact, and rests with all its weight on the upper side. The difficulty which we experience in raising our feet from a wet clay soil is due, in a degree, to the same cause; and if the air could be perfectly removed from beneath our feet, we should be as firmly and immovably planted on the earth as a well-rooted tree.

The weight of the air is also well shown by the bursting of a piece of bladder-skin tied tightly over the mouth of an open jar on the plate of the air-pump. As the pump is worked, the flat surface of the bladder becomes more and more concave, and at length bursts inward with a smart explosion. The same accident would befall the glass jars used on the air-pump, if they were not made of strong glass, and arched in form. Thin square glass bottles are blown purposely to show this, and burst under the air-pump, being either *crushed inward* by removing the air, or *bursting outward* by the expansion of the contained air, when they are surrounded by a vacuum.

32. We can also determine the weight of the air by exhausting a small glass globe fitted by a stop-cock to the pump. Suppose such a globe to hold 100 cubic inches of air at the medium temperature and pressure: if we weigh it before and after exhaustion, we shall find, if the vacuum be perfect, that it has lost nearly 31 grains of weight, which it regains on allowing the air to enter; hence we learn that 100 cubic inches of air weigh about 31 grains. By using other gases besides air, we ascertain by a similar experiment their relative weights and specific gravities, (49, and figure in the same section).

33. *Barometer.*—The *Barometer* is an instrument by which, on principles just explained, we actually measure the weight of the atmosphere. This instrument was invented A.D. 1643, by a celebrated Italian philosopher, named Torricelli. Philosophers up to this time, when called to explain the phenomena of the atmosphere and the rise of water in a common pump, had contended themselves with saying that "Nature abhors a vacuum;" but a well-digger in Florence informed Torricelli, that he could raise water in a pump only 33 feet, and this philosopher at once reasoned, that if nature abhorred a vacuum, there was no reason why she should cease to abhor it when it was more than 33 feet high. He inferred that this column of water must be equal in weight to the entire height of an atmospheric column of equal size. To prove this experimentally, it was only necessary to use a fluid so much heavier than water as to bring the height of the column down to convenient dimensions. Mercury, which is $13\frac{1}{2}$ times heavier than water, was the fluid selected. A strong glass tube about 3 feet long, sealed at one end, was filled with mercury. The finger being placed on the open end as a stopper, the tube was inverted, and the mouth immersed in a small vessel of mercury. On withdrawing the finger the mercury in the tube sank a certain distance, oscillated up and down, and finally came to rest at the height of about 30 inches from the surface of the mercury in the outer vessel. The empty space above the mercury is the most perfect vacuum that can be produced, and is called the *Torricellian vacuum*, in honour of the discoverer of the barometer. If water

were employed instead of mercury, it would require a tube about 33 feet long.

34. *Determination of the Pressure of the Atmosphere.*—Water and mercury are supported at these respective heights by the weight or pressure of the air on the surface of the fluid. Such a column of mercury becomes thus an exact counterpoise for the weight of the atmosphere. If the tube had the area of one inch exactly, and the mercury in the barometer tube stood at 30 inches, we should find that fifteen pounds of mercury would be required to fill the tube. The pressure of the air, then, on the surface of the mercury, is capable of supporting a column of that metal weighing fifteen pounds. This is also the weight of a column of air of the same size, reaching to the supposed limits of the atmosphere. Every square inch of the surface of land or sea is therefore subject to a pressure equal to fifteen pounds, or to a column of mercury 30 inches in height. A man of ordinary size has a surface of about 15 square feet, and he must consequently sustain a pressure on his body of about 15 tons. This prodigious load he bears about with him unconsciously, because the mobility of the particles of air causes it to bear with equal force on every part of his body, beneath his feet as well as on his head, and in the inner cavities as well as on the outer surface; if it were not so, great inconvenience and even death must result. We can easily feel the pressure of the atmosphere on our own persons, by placing one of our hands over the mouth of an air-jar, when a single stroke of the pump will firmly fix the hand, which seems drawn in by what we are accustomed to call *suction*, but which we now see to be only the external pressure of the atmosphere. On letting the air in again, we cease to feel this sensation, because the balance or equilibrium of pressure is restored.

35. The pressure of the air at the surface is not a constant quantity. This is shown by the barometer, the mercury in which will be found to vary in height at different times as much as 2 or $2\frac{1}{2}$ inches between one extreme and another. The fact is, that the quantity of air varies from time to time at the same places, owing to meteorological causes. The inconvenience which travellers have experienced in ascending

high mountains has, it is said on good authority, been very much exaggerated. The heart continues its action under a diminished external pressure, and no serious consequences, it is believed, ever follow, as the bursting of blood-vessels or lesion of the lungs, as some have asserted. On the summit of Chimborazo, Baron von Humboldt found that his barometer had sunk 13 inches 11 lines, and the same philosopher descended into the sea in a diving-bell, until the mercurial column rose to 45 inches; he consequently has safely experienced a change of 31 inches of pressure in his own person.

Limits of the Atmosphere—A person who has risen in a balloon, or on a mountain, to the height of 2·705 miles, or 14,282 feet, has passed through one-half of the entire weight of the air, and finds his barometer to indicate this by standing at 15 inches. The upper limits of the atmosphere cannot be accurately determined, but it is supposed, from the observations of astronomers, to be about 45 miles high. We may judge, then, how extremely thin or rare the upper portions must be, when we have one-half of its entire weight within less than three miles of the earth's surface.

HINTS TO TEACHERS.

BY DAVID P. PAGE.

II.—EXCITING INTEREST IN STUDY.

It is ever an interesting question to the teacher, and one which he should consider with great care—"How can I excite an interest among my pupils in their studies?" The intelligent teacher feels that this is *the* great question; for he foresees that if he fails here, his difficulty in governing his school will be very much increased. He therefore turns his attention with deep solicitude to the *motives* he may present, and the methods he may employ to awaken and keep alive the interest of the school.

If he has reflected at all upon the subject, he has already arrived at the conviction, that it is necessary for the good of all concerned that the interest awakened should be an abiding one; that it should not only not abate during the term of school, but continue—nay, grow stronger and stronger—even after school-days have

passed away. There is, probably, no greater mistake in education, than that of raising in school an artificial excitement, which may aid, perhaps, in securing better attention, but which will do nothing toward putting the mind into such a state, that it will press on in the pursuit of knowledge even after the living teacher has closed his labours.

The higher principles of our nature being aroused with difficulty, are too apt to be neglected by the teacher, and thus they remain in their original feebleness; while he contents himself with appealing to our lower characteristics,—thus doing a lasting injury by unduly cultivating and strengthening them, at the same time that he awakens after all but a temporary interest.

Incentives to Study—Emulation.—The teacher will find, in a greater or less degree, in the mind of every child, the principle of EMULATION. It is a question very much debated of late, *What shall he do with it?* Much has been said and written on this question, and the ablest minds, both of past ages and the present, have given us their conclusions respecting it; and it often increases the perplexity of the young teacher to find the widest difference of opinion on this subject among men, upon whom, in other things, he would confidently rely for guidance. Why, asks he, why is this? Is there no such thing as truth in this matter? or have these men misunderstood each other? When they have written with so much ability, and so much earnestness,—some zealously recommending emulation as a safe and desirable principle to be encouraged in the young, and others warmly denouncing it as altogether unworthy and improper,—have they been thinking of the *same thing*? Thus perplexed with conflicting opinions, he is thrown back upon his own reflection for a decision; or, what is more common, he endeavours to find the truth by *experimenting* upon his pupils. He tries one course for one term, and a different one the next; repeats both during the third, and still finds himself unsettled as he commences the fourth. Meantime some of his experiments have wrought out a lasting injury upon the minds of his pupils; for, if every teacher must settle every doubt by new experiments upon his

classes, the progress that is made in the science and art of teaching must be at the untold expense of each new set of children;—just as if the young doctor could take nothing as settled by the experience of his predecessors, but must try over again for himself the effects of all the various medical agents, in order to decide whether arsenic does corrode the stomach and produce death—whether cantharides can be best applied inwardly or outwardly—whether mercury is most salutary when administered in ounces or grains, or whether repletion or abstinence is preferable in a fever! When such is the course of a young practitioner in a community, who does not confidently expect the churchyard soon to become the most populous district, and the sexton to be the most thrifty personage in the town, unless, indeed, he too should become the subject of experiment?

But is there not a good sense and a bad sense, associated with the term Emulation;—and have not these eager disputants fallen into the same error, in this matter, that the two knights committed, when they immolated each other in a contest about the question whether a shield was gold or silver, when each had seen *but one side of it*? I incline to the opinion that this is the case,—and that those who wax so warm in this contest, would do well to give us at the outset a careful *definition of the term* EMULATION, as they intend to use it. This would, perhaps, save themselves a great deal of toil, and their readers a great deal of perplexity.

Now, it seems to me, the truth on this question lies within a nutshell. 1. If emulation means a *desire for improvement, progress, growth*,—an ardent wish to rise above one's present condition or attainments,—or even an aspiration to attain to eminence in the school or in the world, it is a laudable motive. *This is self-emulation.* It presses the individual on to surpass himself. It compares his present condition with what he would be—with what he ought to be; and “forgetting those things which are behind, and reaching forth unto those which are before, he presses towards the mark for the prize.” “An ardour kindled by the praiseworthy examples of others, inciting to imitate them, or to equal, or even excel them,

without the desire of depressing them,” is the sense in which the apostle uses the term [Romans xi. 14] when he says: “If by any means I may provoke to *emulation* them which are my flesh, and might save some of them.” If this be the meaning of emulation, it is every way a worthy principle to be appealed to in school. This principle exists to a greater or less extent in the mind of every child, and may very safely be strengthened by being called by the teacher into lively exercise; provided always, that the eminence is sought from a desire to be useful, and not from a desire of self-glorification.

2. But if emulation, on the other hand, means a *desire of surpassing others*, for the *sake of surpassing them*; if it be a disposition that will cause an individual to be as well satisfied with the highest place, whether he has risen above his fellows by his intrinsic well-doing, or they have fallen below him by their neglect; if it puts him in such a relation to others that *their failures* will be as gratifying to him as *his own success*; if it be a principle that prompts the secret wish in the child that others may miss their lessons, in order to give him an opportunity to gain applause by a contrast with their abasement,—then without doubt, it is an unworthy and unholy principle, and should never be encouraged, or appealed to by the teacher. It has no similitude to that spirit which prompts a man to “love his neighbour as himself.” It has none of that generosity which rejoices in the success of others. Carried out in after life, it becomes *ambition*, such as fired the breast of a Napoleon, who sought a throne for himself, though he waded through the blood of millions to obtain it.

It is to this principle that the apostle, before quoted, alludes, when he classes *emulation* with the “works of the flesh, of the which things, I tell you before, as I have told you in times past, that they which do such things shall not inherit the kingdom of God.” It is of this principle that the Commentator, Scott, remarks:—“This thirst for human applause has caused more horrible violations of the law of love, and done more to desolate the earth, than even the grossest sensuality ever did.”

Thus *Emulation* is a term which indicates

a very good, or a very bad thing, according to the definition we give it. In one view of it, the warmest aspirings to rise are consistent with a generous wish that others may rise also. It is even compatible with a heartfelt satisfaction, in its possessor, at the progress of others, though they should outstrip him in his upward course. It is the spirit which actuates all true Christians, as they wend their way heavenward, rejoicing the more as they find the way is thronged with those who hope to gain an immortal crown.

In the other view of it, we see men actuated by selfishness mingled with pride, inquiring, in the spirit of those mentioned in Scripture, "Who among us shall be the greatest?" We everywhere see men violating these sacred injunctions of Divine wisdom: "Let no man seek his own, but every man another's wealth."—"Let nothing be done through strife or vain-glory; but in lowliness of mind, let each esteem other better than themselves."—"In honour preferring one another."

If such be the true pictures of emulation, in both the good and the bad sense, certainly teachers cannot hesitate a moment as to their duty. They may appeal to the principle first described,—cultivate and strengthen it; and, in so doing, they may be sure they are doing a good work. But, unless they intend to violate the teachings of common sense, and the higher teachings of Christianity, *I know not how they can appeal to the principle of emulation as defined in the second case.*

But it may be urged that the teacher will find emulation, even in this latter sense, existing in human nature; that he cannot get rid of it if he will; that it will be one of the most active principles to which he can resort in arousing the mind to exertion; and, furthermore, that it has been appealed to by many of the most eminent teachers time out of mind.

To this it is replied, that it is not disputed that children are selfish: and that this selfishness may indeed be made a powerful instrumentality in urging them forward to the attainment of a temporary end. But does the existence of selfishness prove that it needs cultivation in the human character? And will the end, when attained, justify the means? Is the end, whatever it may be, if attained at

such a cost, a blessing to be desired? Will not the heart suffer more than the head will gain?

It may be further urged, that the child will find the *world* full of this principle when he leaves the school; and why, it is asked, should he at school be thrown into an unnatural position? I answer, that evil is not to be overcome by making evil more prevalent; and though there may be too much of self-seeking in the world, that is the very reason why the teacher should not encourage its growth. The more true Christianity prevails in the world, the less there will be of that spirit which rejoices at another's halting; hence I am convinced that the teacher should do nothing to make that spirit more prevalent.

Nor is it essential to the progress of the pupil, even temporarily, since there are other and worthier principles which can be as successfully called into action. If we look carefully at the *expediency* of thus stimulating the mind, we find, that after the first trial of strength, many become disheartened, and fall behind in despair. It will soon be obvious, in a class of twenty, who are the *few* that will be likely to surpass all others; and therefore all the others, as a matter of course, fall back into envy, perhaps into hopeless indifference. Who has not seen this in a class in spelling, for instance, where the strife was for the "*head*" of the class, but where all but two or three were quite as well satisfied with being at the "*foot*?" It does not then accomplish the purpose for which it is employed; and since those who are aroused by it are even more injured than those who are indifferent, their undesirable qualities being thus strengthened, the opinion is entertained that those teachers are the most wise, who bend their ingenuity to find some other means to awaken the minds of the children under their charge.

From what has been said, then, *Emulation* is to be recognized or repudiated among the incentives of the school-room, according to the signification we assign to the term. We have in so many cases seen the advantage of exciting a proper spirit of emulation in the young, that we cannot too strenuously urge its adoption. A word of encouragement, judiciously timed, will always have a beneficial effect.

I.—LESSONS IN FRENCH.

GRAMMAR is the art of speaking and writing a language correctly. To speak a language is to convey our thoughts in that language by means of articulate sounds. To write a language is to convey our thoughts in that language by means of signs or characters, called letters. A French Grammar, written for the use of foreigners, ought not only to contain the rules of the French language, but to compare them with those of the foreign language in which it is to be studied, and to show clearly in what they differ or agree. In French, as well as in other languages, the rules are the result of philosophical reasoning and of usage.

Language, however, even as spoken by the natives of the same country, differs in construction, idiom, and pronunciation, owing to the fact, that some are well educated, some are not; hence a great difference between the language, as generally spoken, and that which is classical and conforms to the rules; and the student of a foreign language ought not only to aim at acquiring such a knowledge of it as shall enable him to express his ideas intelligibly, but to write and speak it correctly. The study of Grammar is the means by which this point is to be gained.

Words spoken or written are composed of syllables; syllables are composed of letters.

These letters, separately or grouped together, represent the sounds and written words of a language; and form a collection which is called the Alphabet.

The French language has no alphabet of its own; that which is used comes from the Latin.

ACCENTUATION.

The five vowels receive modifications in their sound by the use of certain signs placed over them. These signs are called accents.

We have in French three accents; the acute which is marked thus (´), the grave (˘), and the circumflex (ˆ).

The acute accent (´) is only used with the letter *e*, and gives it the sound of the English letter *a* in *bale*, as in *bonté*, goodness.

The grave accent (˘) is used with the letters *a*, *e*, *u*. When used with the first and the last *a*, *u*, it shows only some particular use of these two letters, and does not alter their pronunciation; as in the words *là*, there, and *où*, where. Without the accent, these words signify *the*, feminine and *or*.

It gives to the letter *e* a more open sound than the acute accent, as in the word *progrès*, *succès*, in which *è* sounds as *ai* in *fair*, *pair*, or *a* in *mare*, *snare*.

The circumflex accent is used with the five vowels, and gives them a broader sound than they have naturally, without changing the nature of that sound. This accent has been introduced into the language to show, that, formerly, the words over which it is seen were written with an *s* after the vowel which now receives the accent, as *même* for *mesmes*, *fâmes* for *fusmes*, *fîmes* for *fîsmes*, *côte* for *coste*, *pâte* for *paste*.

OF PUNCTUATION, AND OTHER SIGNS USED IN THE FRENCH LANGUAGE.

The marks of Punctuation are similar in French and in English, as well as the other signs used in writing; they are called by the following names:

Comma,	, <i>virgule</i> .
Semicolon,	; <i>point et virgule</i> .
Colon,	: <i>deux points</i> .
Period,	. <i>un point</i> .
Note of interrogation	? <i>point d'interrogation</i> .
Note of admiration; or exclamation	! <i>point d'admiration, ou d'exclamation</i> .
The Parenthesis,	() <i>parenthèse</i> .
The dash,	— <i>le trait de séparation</i> .
A quotation,	“ ” <i>guillemets</i> .

Cedilla, (*ç*), *cédille*, gives to the *c* the sound of *ss*.

Diæresis, (¨) *tréma*, placed above the vowels *e*, *i*, *u*, to indicate that these vowels do not form a diphthong with the next vowel, but should be pronounced by themselves; as, *poème*, *haïr*, *Saül*.

The hyphen (-) *trait d'union*; this sign is used to connect together, first, compound words, as, *arc-en-ciel*; second, the personal pronouns, nominative and the verb, when placed after the verb in interrogative sentences, as, *amie-la*, *animons-nous*; third, the objective pronouns and the verb in the imperative mood, as, *écoute-moi*, *parle-lui*; fourth, it is also used, when, at the end of a line, a word

being too long must be divided, and the latter part written in the next line.

The apostrophe, (') *l'apostrophe*, which is used to show the elision of a vowel when followed by another vowel, or by an *h* mute: as, *l'homme, l'étude, le homme, la étude*. This sign is employed merely for the sake of euphony.

ELISION.

The apostrophe ('), as we have just stated, is placed between two words to show the suppression of the vowel ending the first word before another vowel or an *h* mute.

This suppression is called elision, and causes the two words to be pronounced together, as if forming but one. The only vowels which suffer elision are *a, e, i*.

This last vowel, *i*, is suppressed only in one word, *si*, if, when this word comes before the personal pronouns nominative of the third persons singular and plural, *il, ils*; thus, instead of writing,

Si il, for *if he*, or *si ils*, for *if they*, the letter *i* is suppressed in the word *si*, and we write, *s'il, s'ils*.

The letters *a, e*, are suppressed in the following words, when the next word begins with a vowel or an *h* mute.

<i>le,</i>	meaning the, him, it,	<i>l'.</i>
<i>la,</i>	" " her, "	<i>l'.</i>
<i>je,</i>	" I,	<i>j'.</i>
<i>me,</i>	" me,	<i>m'.</i>
<i>te,</i>	" thee	<i>t'.</i>
<i>se,</i>	" himself, herself, itself,	
	themselves,	<i>s'.</i>
<i>ce,</i>	" this or that, it,	<i>c'.</i>
<i>de,</i>	" of, from,	<i>d'.</i>
<i>ne,</i>	" not,	<i>n'.</i>
<i>que,</i>	" that, which, whom,	<i>qu'.</i>
<i>parceque,</i>	" because,	<i>parcequ'.</i>
<i>quoique,</i>	" although,	<i>quoiqu'.</i>
<i>puisque,</i>	" since,	<i>puisqu'.</i>
<i>jusque,</i>	" until,	<i>jusqu'.</i>
<i>vú que,</i>	" since,	<i>vú qu'.</i>
<i>dèsque,</i>	" as soon as,	<i>dèsqu'.</i>
<i>quelque,</i>	" some, &c.,	<i>quelqu'.</i>
<i>entre,</i>	" between,	<i>entr'.</i>

In this last word, *entre*, the *e* final may be suppressed, or not before another word beginning with a vowel or an *h* mute; thus, we may write, *entr'eux*, or *entre eux*, *entr'autres*, or *entre autres*, &c.

The words *le, la, ce*, used as objective or nominative pronouns, do not suffer the elision, when placed after the verb in interrogative sentences, or in the imperative mood, and before words beginning

with a vowel or an *h* mute; thus, we say, *apportez le, or la ici*, bring it here; *est-ce à lui à parler?* is it for him to speak?

OF GENDERS.

Gender, in all languages, marks the difference between the sexes.

All that are of the male sex are said to belong to the masculine gender.

All that are of the female sex are said to be of the feminine gender.

This part of the language would present no difficulty to the student, if all the words to which the genders are applied were either male or female; but inanimate objects have no sex, and yet have a gender. In English, this gender is called *neuter*; but in French there is no neuter gender, and the whole family of nouns are either masculine or feminine. How, then, can a foreigner distinguish which of the two he must apply to things? There are no satisfactory rules to guide him in this difficult study; time, practice, and a good dictionary are the only means which may assist him efficiently.

Some grammarians pretend to have established rules which they call complete; but the result of their efforts has only proved the inutility of the attempt. Where, in order to establish a rule, we have to admit nearly as many exceptions as there are cases which conform to the rule; there is no rule, and it is far better to tell the student at once, that he must arm himself with patience and perseverance, than to delude him in an undertaking, which, after all his efforts and loss of time, will leave him, perhaps, further from the point he wished to gain than he was before beginning the study of this difficult matter.

But, although we proscribe as fruitless the modes of gaining a correct knowledge of the genders of the French language, through the medium of mere barren rules, we admit that there are indications which may be of great service to foreigners, and we will give them here, but only as matters for reference, and not to be committed to memory. We repeat, that a good dictionary is the only sure guide on this subject.

The terminations of words are distinguished by grammarians, as either masculine, or feminine.

Words ending with an *e* mute are said to be of the feminine termination.

Words not ending with an *e* mute are said to be of the masculine gender.

These denominatives, however, are far from being of a general application; but, before entering upon the details of the exceptions, we will speak of the nouns which, denoting species, have a fixed gender, independently of their termination.

First; God, angels, cherubim, and seraphim are of the masculine gender.

Second; all names of living beings, and all proper names of men and women, are of the gender of the sex which they represent.

When, however, the same noun is employed to designate both the male and the female in animals, this noun takes the gender of its termination, with the following exceptions.

First; masculine nouns with feminine terminations.

Aigle,	<i>eagle.</i>	Cygne,	<i>swan.</i>
Bièvre,	<i>beaver.</i>	Dromadaire,	<i>dromedary.</i>
Buffle,	<i>buffalo.</i>	Lièvre,	<i>hare.</i>
Capricorne,	<i>capricorn.</i>	Merle,	<i>blackbird.</i>
Crabe,	<i>crab.</i>	Rouge-gorge,	<i>red-breast.</i>
Congre,	<i>conger.</i>	Zèbre,	<i>zebra.</i>

Second; feminine nouns with a masculine termination.

Fourmi,	<i>ant.</i>	Souris,	<i>mouse.</i>
Perdrix,	<i>partridge.</i>	Chauve-souris,	<i>bat.</i>

Third; all diminutive names of animals, whenever the animals of both sexes are called by the same denomination, are of the masculine gender, whatever may be the original noun from which they are derived; as,

Un lionceau,	<i>a young lion.</i>
Un souriceau,	<i>a young mouse.</i>
Un carpillon,	<i>a young carp.</i>
Un perdreau,	<i>a young partridge.</i>
Un vipereau,	<i>a young viper.</i>
Un bécasseau,	<i>a young woodcock, &c.</i>

The word *bécassine*, snipe, being feminine, seems to be an exception to this rule, but it is not so; because, although this noun is derived from *bécasse*, it designates another species of birds, and not a young one of the same family.

Where the diminutive names of animals are not the same for both sexes, they follow the general rule, and are of the same gender as the object which they represent; as, *

Un poulain,	une pouliche,	<i>a colt.</i>
Un cochet,	une poulette,	<i>a young chicken, &c.</i>

Fourth; diminutive names of inanimate objects take, generally, the same gender as the nouns from which they originate; as,

Batelet,	<i>masc. from bateau, masc., a small boat.</i>
Maisonette,	<i>f. „ maison, fem., a little house.</i>
Globule,	<i>masc. „ globe, masc., a small globe. &c.</i>

We say generally, because there are exceptions to the above rule; as,

Corbillon,	<i>masc. from corbeille, fem. a small basket.</i>
Soliveau,	<i>„ „ solive, „ a small beam.</i>
Cruchon,	<i>„ „ cruche, „ a small pitcher.</i>
Savonnette,	<i>fem. „ savon, masc. a wash-ball, &c.</i>

Fifth; all the names of the days, months, and seasons of the year are of the masculine gender; but when the word *mi*, half, is prefixed to the name of a month, the compound word thus formed becomes feminine; as

La mi-mai,	<i>the half of the month of May.</i>
La mi-août,	<i>„ „ August.</i>

So, also, *La mi-carême*, half of Lent.

The saint-days are also feminine: as,

La Saint-Jean,	<i>Saint John's day.</i>
La Toussaint, &c.,	<i>All Saints's day, &c.</i>

because these compound words are elliptical, and mean,

La moitié de Mai,	La moitié d'Août,
La fête de St.-Jean,	La fête de tous les saints, &c.

Sixth; names of trees are masculine, except *yeuse*, *holm*.

Names of shrubs are masculine, except

Aubépine,	<i>hawthorn.</i>
Bourdaïne,	<i>black alder.</i>
Epine,	<i>thorn.</i>
Ronce,	<i>briar.</i>
Vigne,	<i>vine.</i>

Names of metals are all masculine, as well as those of minerals, with very few exceptions.

Names of colours are all masculine, without reference to their termination.

Seventh; names of mountains, except those which have no singular.

The names of winds, except,

La bise,	<i>north-east wind.</i>
La brise,	<i>light wind.</i>
La tramontane,	<i>tramontane.</i>
Les moussons,	<i>moonsoon.</i>

The nouns designating the cardinal points, and names of countries, take the gender of their termination, except,

Le Bengale,	<i>Bengal.</i>
Le Mexique,	<i>Mexico.</i>
Le Peloponèse,	<i>Peloponnesus.</i>
Le Caire,	<i>Cairo.</i>
Le Maine,	
Le Perche,	
Le Rouergue,	
Le Bigorre.	
La Franche Comté,	

and perhaps a few others.

Names of towns, boroughs, and villages are masculine, except those which take the article before them; in which case the names are elliptical; as,

La Rochelle,	<i>for La Ville de Rochelle.</i>
La Nouvelle Orléans,	<i>„ La Nouvelle Villed'Orléans, &c.</i>

But, when the name of a city is preceded by the word *ville*, city, which is feminine, then the compound expression is of the feminine gender; as,

La ville de Paris.	La ville de Rouen, &c.
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Eighth; ordinal, distributive, and proportional numbers; adjectives, infinitives, prepositions, adverbs, used as nouns, are all masculine; as,

Le tiers, <i>a third.</i>	Le quart, <i>the fourth, &c.</i>
Un cinquième, <i>a fifth.</i>	Un dixième, <i>a tenth.</i>
Le quintuple, <i>the quintuple, &c.</i>	
Le nécessaire, <i>what is necessary.</i>	L'utile, <i>what is useful.</i>
Le boire, <i>drinking.</i>	Le manger, <i>eating, &c.</i>
Le mieux, <i>what is best.</i>	Le contre, <i>what is against, &c.</i>

We must except *the half*, *la moitié*, and the following elliptical expressions;

Une courbe, <i>for une ligne courbe,</i>	<i>a curve.</i>
Une perpendiculaire, <i>for une ligne, &c.</i>	<i>a perpendicular.</i>
Une parallèle, <i>for une ligne parallèle.</i>	<i>a parallel, &c.</i>
Une antique, <i>for une médaille, une statue antique.</i>	<i>an old medal or statue,</i>

as well as all similar expressions.

Ninth; all nouns expressing virtues are feminine, except *courage* and *mérite*, *courage* and *merit*.

All nouns expressing vices are feminine.

All nouns expressing crimes are masculine.

It will be well for the reader to make himself thoroughly acquainted with the preceding examples. Without a due knowledge of the elements of grammar, it will be impossible to make any progress.

(To be continued.)

BERZELIUS.

"IN the year 1778, Sweden lost the illustrious Linnæus, but in the August of the year following, the loss was replaced by the birth of Berzelius."

Berzelius is, without doubt, the greatest chemist of the century. Others have made brilliant discoveries, and created profound and ingenious theories, but no individual has played so important a rôle in science, or accomplished works of such lasting utility. During thirty years he may be said to have given the directing impulse to the onward march of chemical investigation. His genius was only equalled by his persevering industry, to which latter quality he was largely indebted for the high position he attained.

Jean Jacob Berzelius was born on the 29th of August, 1779, in Ostgothland, a province of Sweden. Early left an orphan, Berzelius's child-life was not a happy experience, and there was indeed scanty promise evidenced prophetic of his after renown. Living with different connections, who vouchsafed their protection from a constrained sense of duty rather than from affection, the necessities of the domestic relation proved mutually burdensome, and his natural energy was subdued by the discomfiting home influence.

At thirteen years of age Berzelius entered the school at Nörköping, where he remained during the next four years, a lapse of time that afforded little profit to himself or satisfaction to his preceptor; judging from the fact that when, in the autumn of 1796, Berzelius, with several others, left for the University at Upsala, the maestro at Nörköping sent to the University authorities a list of the applicants, and wrote opposite the name of his somewhat impracticable pupil these unpromising words:—"Indifferent in behaviour, and of doubtful hope." This introductory recommendation, as a natural consequence, resulted in a cold reception and suspicious mode of treatment.

Thus ill-omenedly did the new student commence his collegiate career; nor is it to be wondered that, rendered indolent by want of sympathy, Berzelius allowed the next year to pass by as unproductively as the preceding ones. At the expiration of that time, pecuniary difficulties in-

duced him to leave college for a while, and become private tutor to a family in East Gothland. He returned in 1798, and prepared for the critical examination (termed the Medico-philosophical examen) when, owing to the dulness of the student or obtuseness of the lecturer, he was well-nigh rejected for his deficiency in chemical knowledge,—Azfeliuſ, the professor of that science, saying to his brothers in office, “If *you* are satisfied with the young man, I will not turn him back.” Berzelius was allowed to pass; but a second examination was postponed for a year. The discredit of this partial failure stung him into new exertion. He now went to work in good earnest. Azfeliuſ confined his lessons principally to lectures, rarely experimenting. Berzelius required further practical operation, and continually haunted the laboratory, which was always open to the students; but he was not a favourite—the laborator was rude—he could not continue his visits. Still the noble curiosity aroused in him would not be quieted. His genius was to him an unresting spirit, asking incessantly, “Light! more light!” A glass retort was left carelessly on a table in the laboratory. To possess it was the acme of his desires. He was longing to try an experiment at home. It was a happy chance, not to be lost through over-scrupulousness. Berzelius hesitated but a moment, then seizing his prize, rushed to his own apartment, and locked himself in for hours. With the aid of this instrument he made his first great discoveries, and produced results that for a year past had been tried in the laboratory in vain.

The summer of 1779 Berzelius spent at Wadstena, as assistant to an apothecary; where, from an Italian, he acquired the art of working in glass. The next summer he was engaged by a physician at the mineral waters of Medini. These waters he analyzed, and made the analysis a point in his second college examination in 1800. But Azfeliuſ had no confidence in his talents, and undervalued his work: he passed without credit. Ill-luck still pursued him. The fruits of some researches sent through Azfeliuſ to the Academy of Sciences at Stockholm, after three years’ delay, were returned, with the laconic statement that the learned body

did not recognise the new nomenclature which he had adopted. The same opposition that killed Keats, made Byron a poet:—Berzelius was formed of the sterner stuff. Neither stupidity nor prejudice could baulk his rapid progress. In 1803, he settled in Stockholm, and was appointed Adjunct of Medicine and Pharmacy, in the College of Medicine. In 1804, he took his doctor’s degree, and in 1807 was appointed Professor in the School of Medicine at Stockholm,—a situation that he held for forty years, until the time of his death.

The Academy having refused to sanction the publishing of his papers, Berzelius, in 1806, commenced a scientific periodical, devoted chiefly to chemistry and mineralogy. His course was now steadily onward. His opponents yielded their objections. In 1808, he was elected member of the Academy, became President in 1810, and in 1813 was allowed a salary by the Institution, on condition that he would give them the benefit of the researches that, but a few years since, had been rejected as chimerical.

In 1813 was issued his Annual Report on Physics, Chemistry, and Mineralogy, which was regularly continued during twenty-five years. In that publication he discussed the chemical works of the year.

But we cannot pause to enumerate Berzelius’s services in the cause of science. Our purposed task was mainly achieved in sketching the difficulties he encountered and overcame in the outset of his career. As Secretary of the Academy, he became world-renowned. Honours poured in upon him from all directions. His sovereign created him Knight of the Grand Cross of Vesa, in 1829, and elevated him to the rank of baron, in 1835. He died in 1848.

To Berzelius belonged the honour of successfully applying the great principles of Davy and Dalton in inorganic chemistry in unfolding the laws of the structures of the animal and vegetable kingdoms. He was also the discoverer of several elementary bodies; and to his skill in manipulating are we indebted for many of the processes now in established use.

The amount of labour achieved by Berzelius seems marvellous. The secret

is explained in a sentence:—he was the most systematic of men. Indolent and unpunctual as a boy, the knowledge of divine order, which enabled him to complete his manifold designs, was the growth of a matured intellect. The world were now a loser, had he wanted that habit of strict regularity, which we are apt to regard as incompatible with the more brilliant gift of genius.

DEMOSTHENES.

DEMOSTHENES has been ranked above all other orators by the consent of all ages; and it is scarcely possible to tell whether the judgment of ancient or of modern times is the strongest proof of the justice of this decision. For if, on the one hand, it is a convincing argument for the surpassing merits of this orator, that his cotemporaries, at a time when there were so many and such celebrated competitors for the same honour; at a time, indeed, when eloquence might almost be termed the common language of Attica, should have concurred in declaring him far beyond all rivalry,—surely, on the other hand, it is not a less convincing proof of the truth of this decision, that the judges of modern times, though compelled to read Demosthenes when Greek is no longer a living language, and, consequently, has lost to us so much of its beauty, and more than half its power, can still discern sufficient to induce their unanimous concurrence in the sentence of antiquity, and to compel them to contemplate the great Grecian orator as the model for all succeeding ages; that model which all must be content to imitate, which few dare aspire to rival, and which none can ever hope to excel. Nor is this a mere empty prejudice in favour of antiquity. Demosthenes, unlike many other remains of the past, has rather lost than gained by age. Still, however, though many of his minuter beauties must escape us, his more striking and prominent excellencies are obvious enough, and justify our admiration. We look upon his productions as we might upon a statue of Phidias;—time may have touched it a little; the glow, the transparency, the polish, the freshness of the marble may be gone; but there is still the outline

of immortal beauty; we still see the features, the expression, the form, the attitude, which none but Phidias could embody or conceive.

We shall now venture to make a few necessarily brief remarks upon those excellencies which have procured for this orator such unrivalled fame. And, first, if we consider him merely as the *rhetorician*, we cannot but perceive that he possessed every possible advantage which the deepest knowledge of his art, *as such*, could confer. He was a complete master of the language in which he spoke; a language, too, celebrated as peculiarly musical and expressive; unrivalled for its copiousness, flexibility, and power of combination. And each expression in Demosthenes is the most happy which such a language could afford; each is chosen with inimitable art; and, not only was he thus felicitous in the choice of his expressions, but equally so in the collocation of his words, and in the composition of his sentences. One of his most frequent, and, apparently, one of his most successful artifices, is, suspending the whole meaning of a long sentence, or even paragraph, upon one or two words at the close, thus insuring the most intense attention on the part of his audience to the last.

The chief peculiarities of the *style* of Demosthenes seem to be—*energy*, *nervous conciseness*, and the most *chastised simplicity*. By conciseness, however, we do not mean that he is always sententious, although he is often extremely so; but we mean that there are no redundancies, no superfluous expressions, no unmeaning epithets, no useless synonymes; he rejects every word which is not either a most important accession to the sense, or most powerfully illustrative of it. It is true his sentences are often very long, and, when they are so, roll out with resistless energy and power; but still all is nervous and compact, and perfectly consistent with the *conciseness* of which we have been speaking; no member of such sentence is a mere echo of the sense, a mere duplicate of what precedes or what follows it, but each forms a distinct feature and imparts some new idea; not one syllable is useless. In respect to that severe and chaste simplicity which we mentioned as a characteristic of the

style of Demosthenes, there is, perhaps, nothing which more forcibly shows the perfection to which Demosthenes must have brought his art, since there is scarcely any error into which the rhetorician, especially the *professed* rhetorician,—as was the case with Isocrates, for instance,—is so apt to fall, as that of a too ornamental and embellished style. There is nothing of this in Demosthenes. There are no fine passages thrown in for the sake of effect, without reference to the subject; no fine colouring, no gilding; there is nothing but what is in character with the chastened beauty of the whole. It is for the same reason that we find Demosthenes so sparing of his figures; not but what he could have used them more prodigally, but he never employed an image, unless, in the first place, it was most exactly illustrative of his subject, and then, which is almost of as much consequence, unless he could introduce it with *effect*. Thus his images are but few, and generally briefly expressed. But though he seldom indulges in long and formal similes, yet his language is evidently in the highest degree metaphorical, which, if appropriate, must always be the most striking. And the Greek, it will be observed, is peculiarly adapted for this; as, from the flexibility and compression of the language, a whole simile may often be condensed into a single compound. Numberless instances of this occur in Demosthenes; where a word, if applied from its ordinary to a particular use, calls up to the mind the whole image which it was calculated to suggest, as vividly and as forcibly as though it had been introduced with all the formalities of a simile. Thus, when in saying that by his administration he had thrown some of the states of Greece as a shield between Attica and Philip, he enters into no lengthened comparison; he merely uses the technical expression which is applied to a warrior's covering himself with his shield. Numberless other instances of this might have been discovered, could we become more familiar with the language. We must add one word more upon the reasoning of Demosthenes: it is always nervous, vigorous, pointed, and conclusive, and each argument is complete within itself; yet he seldom, if ever, follows up a long and close train of reason-

ing; and purposely, because he felt that this was incompatible with the most efficient oratory. Thus, after one of his brief, but triumphant arguments, or even in the midst of it, he will often burst out into some powerful and unexpected appeal to the passions of his audience. This, it must be confessed, was not very *logical*; but what he thus lost in logic, he amply gained in popularity. None knew better than he, that he was teaching the Athenian mob neither mathematics nor philosophy, and that, therefore, he must suit his arguments, not to the academy, but to the public assemblies. What has been said of each particular argument, might be said of the general arrangement of his subjects. Nothing can, at first sight, appear more *illogical*, and yet all was the effect of the most consummate art.

Thus, then, as a mere rhetorician, Demosthenes might be denominated perfect. But still, it is not in the mere knowledge of his *art, as such*, that the highest excellence of Demosthenes consists, nor is it to this that the mighty effects of his oratory are principally attributable. His exquisite composition may be denominated the form—beautiful, it is true, but still *only* the form in which the *spirit* of Demosthenes' eloquence lived and breathed. That spirit was the lofty and impassioned enthusiasm with which he entered into subjects well worthy of all the enthusiasm they inspired; subjects full of grandeur, elevation, and sublimity. Demosthenes felt as became a Greek in that period of national degeneracy and shame, in which he was called upon to take an active part in the councils of his country; he felt a noble indignation when he saw his countrymen, so long the brave, the generous, and the free, tamely sinking into slaves; the liberty, the glory, the patriotism, and, above all, the example of their ancestors forgotten, and Greece itself spurned by the foot of a barbarian. Hence it was that that intense and all-absorbing feeling in the *subject*, so essential to every true orator, and with which perhaps Demosthenes was more deeply inspired than any man that ever lived, was all poured forth upon sentiments well worthy of it. The interests of his country, the rights of Greece, the duties of the freeman and the patriot, the achievements and trophies of their fathers, the

claims of their children, and, above all, their own infamy and degradation; these are the themes, and nothing beneath them, upon which he is perpetually exerting himself. With such an elevation of sentiment, then, and with his unexampled energy and earnestness, we can scarcely be surprised that his countrymen should have thought him inspired; he must have appeared, not so much the mere advocate of his country, as what he expressed himself, one, whose very being was identified with its welfare and glory. He must have looked, not so much a merely human orator, as the very genius of Greece, pleading with the degeneracy of Athens.

The celebrated oration on the Crown is a rich specimen of all the varied excellencies of Demosthenes; but it possesses in an eminent degree that sublimity and elevation of sentiment to which we have just referred. This is indeed its great charm, as it is its chief strength. Æschines had accused Demosthenes of being the cause of all the disasters which had befallen Athens, by his determined opposition to Philip, and the prosecution of the war against that monarch. Demosthenes, in reply, amongst many other arguments, lay especial stress upon the following. He tells Æschines that he should have proposed more advantageous measures in the hour of danger, instead of venturing to censure those which had been adopted merely because they had been unfortunate. In this part of his oration it is that he institutes his celebrated comparison between the patriotic counsellor and the informer. He then proves that he was by no means responsible for the *result* of his measures, which was entirely beyond his control; and that his accuser, instead of charging him with the unfortunate issue of his administration, ought to have proved, either that the measures themselves were not the best that could have been adopted, or that the author of them had not taken every possible step to ensure their success. But the great point upon which he exhausts all his art and strength, is to show that the policy he had pursued, however disastrous in its results, however slight its chance of success, was that, and that alone, which was consistent with the glory of his country; and that Athens could with

honour adopt no other; that while there was the slightest hope of victory, while Greece had one foot of ground upon which she might do battle for her rights, it was their duty to persevere in their opposition to Philip. A less eminent orator might have stopped here. But Demosthenes, in his famous passage of the oath, goes a step farther, and declares that, had they all *foreknown* the ruinous issue of their efforts, still that they must have pursued the very same conduct, if they wished to act worthily of themselves, their ancestors, or their country. We can scarcely be surprised, then, that he should have an overpowering influence upon the minds of the Athenians; their very misfortunes must have been endeared to them, since they were thus associated with the names of freedom and of Greece; it must have more than reconciled them to their lot to be thus told, that they had well imitated those ancestors whom they so enthusiastically admired; that they had trodden in the footsteps of their patriotic fathers, at least with the same self-devotedness, if not with the same success; and that the heroes of Marathon had lived and died once more on the field of Chæronea. We shall conclude these imperfect remarks by attempting to translate the famous passage of the oath; conscious, however, that the English, even if employed by a master's hand, would still be inadequate to convey the energy, the expression, the spirit of the original. Demosthenes proceeds thus:

"Since Æschines has argued so much from the *results* of my policy, I shall venture a daring assertion. But let me not be charged with extravagance; let me be judged with candour. If, then, the consequences of our conduct had been well known to each; if you had foretold it, Æschines; if you had thundered out your ill-omened prophecies; you, who never spoke at all; still must the city have adhered to the very same measures, if she had cast one thought upon her fame, her ancestors, her posterity. For now she can only seem unfortunate; and misfortunes befall all men, wherever it is the will of heaven to afflict them. But, if that Athens which once stood foremost for the rights of Greece had deserted her post in the hour of danger, she would have

been justly censured as a traitor; and if those rights had been abandoned without one struggle, for which our fathers bravely met every danger, who would not have spurned you? And with what face should we have dared to look upon those ambassadors who visited the city, if we had been found in these misfortunes, without the credit of having exerted ourselves to avert them; if another state had started to your post of glory and of peril, and had fought without your assistance—without you, the inhabitants of a city, which in ancient time never preferred disgraceful security to honourable danger? What Greek, what barbarian knows not, that Thebes, that Lacedæmon, more powerful than Thebes, that even the king of Persia, would have willingly permitted this state the peaceful enjoyment of her possessions, and even extend her territories, if she would only be tamed to slavery, and relinquish her high station in Greece? But Athenians, or at least the Athenians of that time, justly thought such a proposition unworthy of their country, their spirit, their nature; nor was any one ever able to persuade this city to live in a tranquil, but still infamous, subjection to a tyrant power. Our whole existence has been one perpetual struggle for our rights, our freedom, our renown; and so illustrious is such conduct in your eyes, so accordant with our manners, that those of your ancestors who have most devotedly pursued it, are the constant objects of your applause. And justly; for who but must admire the heroism of those men, who abjured their country and their homes, and committed themselves to their ships, only that they might still be free; who chose Themistocles, who advised these measures, as their leader,—for the Athenians of those times sought no popular orator, no general, to show us how we may obtain an easy slavery;—they would not even live, except they could live in freedom. Were I, then, to attempt to show, that *I* infused into you these sentiments so worthy of our fathers, who would not justly reprove me? *I* only wish to show that these sentiments are your own; that our country was actuated by them long before my time: but still *I* claim some honour for having myself adopted them in all my public conduct. *He*, then, who accuses

this public conduct, who calls upon you to punish me, as one who has been the cause of all our fears and perils, despoils me, it is true, only of my present honour, but strips you of the applause of all succeeding ages. For, if you condemn me because my public measures have been unworthy of my country, then it will appear that you, who adopted those measures, have yourselves been acting wrong; not that your present miseries result from the waywardness of fortune. But it cannot be; it cannot be, my countrymen, that you have done wrong in rushing upon peril for the safety and freedom of Greece! No! By those ancestors who fell on Marathon—by those who were arrayed at Plataea—by those who fought at Salamis—who died at Artemisium—by all those patriots of ancient times whose ashes are preserved in the public sepulchres; and all of whom their country pronounced worthy of the same honours; not merely those who were successful, Æschines,—not the victors only! And justly, the duties of the brave they all performed—the result was dependent upon a higher power.”

WHAT IS LIFE?—The present life is sleeping and waking; it is “Good night” on going to bed, and “Good morning” on getting up; it is to wonder what the day will bring forth; it is sunshine and gloominess; it is rain on the window as one sits by the fire; it is to walk in the garden, and see the flowers open, and hear the birds sing; it is to have the postman bring letters; it is to have news from east, west, north, and south; it is to read old books and new books; it is to see pictures and hear music; it is to have Sundays; it is to pray with a family, morning and evening; it is to sit in the twilight and meditate; it is to be well and sometimes to be ill; it is to have business to do, and to do it; it is to have breakfast, and dinner, and tea; it is to belong to a town, and to have neighbours and to be one in a circle of acquaintance; it is to have friends to love one; it is to have sight of dear old faces; and with some men it is to be kissed daily by the same loving lips for fifty years; and it is to know themselves thought of many times a day, in many places by children, and grandchildren, and many friends.”



HALOS.

"DEAR papa, will you tell me why the moon looks so funny?" said little Sydney to his father, who was reading a book in the drawing-room.

"Yes, my dear!" said Mr. Thompson, "and if you call your sister Rose, I will explain the reason to both of you."

At this moment Mrs. Thompson and her daughter entered the drawing-room, and their attention having been attracted towards the window by the impatient Sydney, they were equally interested in the peculiar appearance which the young philosopher described as being "so funny."

"That singular appearance that you

observe round the moon, is called a halo, and is a sure sign that we shall soon have rain; and as it is unusually large to-night, I have no doubt that the rain-clouds are very close, because when it is not so large the rain is generally longer before it comes. This peculiar phenomenon is caused by fine rain, which is suspended in the upper regions of the air. Sometimes a halo is observed round the sun; but as the light of that orb is too dazzling for the eyes, solar halos are not so frequently observed as lunar halos, unless when the image of the sun is seen in still water, or in a mirror blackened at the back. Solar, or sun halos, arise from the same cause as lunar halos; and when we observe one of

the former, we may be certain that we shall have a fall of rain that will last for four or five hours.

"When the sky is invested with light clouds, we observe complete, or only portions of luminous rings round the sun; sometimes these are faintly, and at others strongly coloured, having all the bright hues of the rainbow."

"What do these phenomena depend upon, dear papa?" said little Rose.

"The phenomena of interference, my child," said the fond father. "And to illustrate it more simply, I will show you an experiment to-morrow that will enable you to understand the thing better. If you remind me, I will cover a sheet of glass with lycopodium seed, and then when you look through it at the flame of a candle, you will observe a halo, the small particles of seed taking the place of the vesicles of vapour, which interfere with the rays of light in the same manner as the minute particles of seed."

"Halos do not always assume the same form, and they also differ in colour. For example, when Captain (Sir E.) Parry was in the arctic regions, he observed and measured several halos, and upon one occasion he noticed one of these curious luminous discs like a very large wheel of light suspended in the heavens; the sun occupying the centre of it."

"Many remarkable halos have been noticed by eminent scientific men from time to time, but you would not remember them all, and therefore it is useless to name them."

"The simplest form of the halo is that of a white concentric ring round the sun or moon, caused by the small globules of vapour, which I told you of before, and which are said to vary about from $\frac{1}{5000}$ th of an inch to $\frac{1}{30000}$ th of an inch in diameter."

"Halos are observed in various climates, from the arctic to the antarctic regions. Humboldt observed a curious lunar halo at Cumana, another at Mexico, and one between latitude 15° of the equator. In our own climate many remarkable examples of this singular optical phenomenon have been frequently observed, sometimes singly, and at other times associated with parhelia, or mock suns, which occur in the vicinity of the great luminary."

"Many theories have been framed and placed before the scientific world, endeavouring to explain the formation of halos; but for the most part they have failed, and we are now puzzled by two; 1st, that of Mariotte; and, 2nd, that of Fraunhofer and Sir John Leslie. The first supposes that the phenomenon arises from the refraction of light passing through small particles of ice or snow, floating in the higher regions of the air: and the other two consider that it is the deflection, and not refraction of light, in passing by the small globules of water suspended in the upper regions of the air. Both these theories have strong advocates; but the latter appears the more correct, because halos are often observed when there are not any particles of ice or snow suspended in the atmosphere."

"There are many other peculiarities connected with halos; but you are too young to understand the scientific description of them; and they are, moreover, uninteresting to those who do not make the science of meteorology their study."

"Thank you, dear papa," said Sydney and Rose, "we shall endeavour to remember all that you have said, and then, perhaps, when we know more, you will tell us all about the other curious things connected with halos."

EARLY EDUCATION AMONG THE ANCIENTS.—THE GREEK AND ROMAN YOUTH.

BY E. E.

A KNOWLEDGE of the general customs of education in other nations will furnish us with very important data for determining the evils of our present customs, and for indicating the direction in which some wise change may be made, enabling us to distinguish what is essential from what is simply accidental in our habits of life. I shall therefore call attention to certain facts in the history of those nations where the greatest care has been paid to education, and where the successful result makes the method pursued worthy of study.

I now direct attention to the ancient Greeks, because we find amongst that people a remarkable degree of attention paid to those very points of education

which we so singularly neglect, and it will be exceedingly interesting to notice the results which they obtained.

The most remarkable feature in Grecian education was the bodily exercises, which formed the foundation of all other training. The Greeks considered gymnastic exercises to be as necessary for the *preservation of health*, as medicine is for the cure of diseases. The whole education of a Greek youth was divided into three parts—grammar, music (and some mention drawing and painting), and gymnastics. Gymnastics, however, were thought by the ancients a matter of such importance, that this part of exercise alone occupied as much time and attention as all the others put together! And while the latter necessarily ceased at a certain period of life, gymnastics continued to be cultivated by persons of all ages, though those of advanced age naturally took lighter and less fatiguing exercises than boys and youths. The ancients, and more particularly the Greeks, seem to have been thoroughly convinced that the mind could not possibly be in a healthy state unless the body was likewise in perfect health; and no means were thought, either by philosophers or physicians, to be more conducive to preserve or restore bodily health, than well-regulated exercise.

Gymnastic exercises amongst the Greeks were as old as the Greek nation itself. At first they were of a rude, and mostly of a warlike character. They were generally held in the open air, and in plains near a river, which afforded an opportunity of swimming and bathing. As the nation advanced in civilization, these exercises assumed a wider character; they were employed not only to harden the body for military purposes, but to give to its movements grace and beauty, also to restore the health when lost, and to make the body the basis of a sound mind; and large classes of men pursued these exercises as a profession, contending for the prizes at the public games.

At an early period in their history, the Greek towns began to build their regular gymnasia as places of exercise for the young, with baths, and conveniences for philosophers, and all persons who sought intellectual amusements. There was probably no Greek town of any importance

which did not possess its gymnasium. Athens possessed three great gymnasia to which several smaller ones were afterwards added. These buildings were all constructed on the same general plan; there were porches, with seats for conversation; a large hall, adorned with sculpture and the statues of great men; hot and cold baths, covered squares for winter exercise, and open ones for milder weather, and walks for those who were not exercising. Much attention was paid to the outward and inward splendour of the gymnasia; the highest art of the age was employed to decorate them, and the statue of Hermes, their tutelary deity, was everywhere conspicuous.

The gymnasia were under the control of the state; their regulations were exceedingly strict, and some of the violations punished with death. The chief officer, the gymnasiarch, exercised magisterial power over all persons connected with the institution. He removed all teachers, philosophers, and sophists, when their influence was injurious to the young. He superintended the solemn games at certain great festivals, and his office was held in such esteem that it was sought for as a high honour.

Another class of officers was appointed to inspire the youths with a *love of morality*, and to protect their virtue from all injurious influences. These officers were required not only to be present at all their games, but to watch and correct them whenever they might meet them, not only within, but without the gymnasium. They were special teachers of exercise, who were required to understand all the exercises practised in the gymnasium; they were also expected to know their physiological effects on the constitutions of the youths, and to assign to each individual the exercises most suitable to him. Other officers regulated the diet of the pupils, and acted as surgeons. There were sometimes special teachers of games at ball,—for the ball was in universal favour amongst the Greeks, and was here, as at Rome, played in a variety of ways. It is both amusing and instructive, in these recorded games, to observe how human nature, 2,000 years ago, resembled the nature of to-day; the history of its efforts should be no useless tradition to us. In one favourite game,

one boy holding the end of a rope, tried to pull the boy who held its other end across a line, marked between them on the ground. The *top* was as commonly in use amongst boys then, as in our day. We have, too, the game of five stones, which were thrown from the upper part of the hand and caught in the palm. Another game, in which a rope was drawn through the upper part of a tree or post. Two boys, one on each side the post, turning their backs to each other, took hold of the ends of the rope, and tried to pull each other up. These few games will serve to show the nature of gymnastic *sports*; we can but refer to the more important games, as jumping, leaping, running, throwing the discus, wrestling, dancing, &c.

The education of boys up to the age of sixteen was divided into the three parts mentioned above, so that gymnastics formed only one department, but during the period from their sixteenth to their eighteenth year, the instruction in grammar and music seems to have ceased, and gymnastics were exclusively pursued.

Such was the basis of education throughout Greece; but the laws of the Lacedæmonians watched over it with still stricter care. Amongst them public education was common to rich and poor. From the first moment of life, the child was an object of attention to the state. Even before birth, the mother's apartments were surrounded with pictures of youthful beauty, that these bright images might, through her organization, stamp her child with beauty. The infant's cradle was surrounded by warlike instruments, that they might become from the earliest moments a part of his life. The clothing allowed perfect freedom of movement to all its limbs; it was suffered to cry freely, but no harsh word was allowed to excite its tears or produce a feeling of terror. Until the age of seven, it grew up under the parental influence, permitted to play freely, to regard the kind of food given to it with indifference, accustomed by degrees to darkness and solitude, and ignorant of the feeling of fear. At the age of seven the state superintended the further education of the child. One of the chief men of the republic was placed at the head of the children; he separated them into classes, and to each class a young chief, noted for

wisdom and courage, was appointed. They submitted to his orders and chastisements; their hair was cut off—they learned to walk bare-footed, to wear a single garment summer and winter, to sleep on rushes, which they gathered on the banks of the Eurotas. They were never left alone; their exercises were performed under the eye of the aged and the chief officer of public education; their young chief was constantly at their head when they engaged in combats, swam across the Eurotas, hunted, raced, or attended the exercises of the gymnasium. They supped on plain food, which they cooked themselves, the stronger carrying the wood, the weaker the vegetables and other food. After supper some were directed to sing, others must answer questions, thus indicating their intelligence and disposition—as, “Who is the most honest man in the city?” “What do you think of such an action?” The answer must be exact and to the point—those who failed were punished. Little literary education was given them, but they were taught to express themselves clearly, to join in the exercises of dancing and music, and to sing the praises of their gods, and the exploits of those who had died for their country. They were visited daily by magistrates, who inspected their education and habits, and saw if they were growing too fat. This last condition being considered an indication of *laziness*, unfortunate individuals who displayed too much *embonpoint* were cited before the public tribunals and threatened with exile! The greater part of the day was spent in the gymnasium.

At the age of eighteen, the pupils were not released from the discipline of the schools, as in many cities of Greece. Lycurgus wisely considered this a critical age, and new exercises and labours were imposed, to hinder the development of the passions. The chiefs required an increase of modesty, submission, temperance, and zeal. The singular spectacle was presented of a brilliant youth, full of pride, courage, and beauty, behaving with the decency and reserve of the young girls who served in the religious festivals.

This was not the result of external restraint, affecting simply the manners; their *enthusiasm* was enlisted in this reserve, by the emulation of rival classes, who excited

each other to the love and practice of virtue, according to their standard, by the glory of victory.

These bodies of young Spartans were spread over the country, and exposed to hardships; they were taught to study its aspect, and learn the best method of defending it. They attacked wild boars and savage beasts, and were instructed in the manœuvres of the military art.

I have dwelt somewhat in detail, because Greece stood first among the nations of antiquity in physical and mental development—the highest in every kind of excellence, according to the standard which then existed in the world. In examining the means by which this condition was reached, we remark particularly the following points—1st. The physical discipline of the young was considered the basis of all education. 2nd. This physical training was not limited to a portion of the day, or to any single part of the organization, but beginning with early childhood, it was continued constantly to the period of confirmed manhood, and comprised dress, food, bathing, the air breathed, the habits of life, as well as exercise in its various branches. 3rd. The instruction given in mental cultivation never interfered with the fullest attention to the use of these physical agents; thus the beautiful groves and the lofty halls, adorned with objects of sublime art, where the instruction was carried on, could in no way injure the organic health of the body, while they refined the senses by the ennobling influences of nature and art. 4th. The moral and religious welfare of the young was carefully attended to. They were heathen nations; their religion was not ours; but what seemed to them the highest virtue was carefully instilled into the minds of their children, not so much by direct teaching, as by the influences which surrounded them; the careful oversight of all their actions; the hymns they learned to sing, the ornaments of their edifices, the conversations they listened to, the religious ceremonials in which they assisted, and the whole spirit of society. 5th. This system of education, based upon physical development, was applied with remarkable advantage to their young girls; the superiority of the women thus educated was displayed

with singular success in every respect; they were more faithful wives, stronger mothers, wiser domestic rulers, more patriotic citizens, and nobler human beings, than the women who were educated in sedentary and secluded pursuits. 6th. This long and complete physical training favoured in a remarkable degree a brilliant *mental* growth; for they stand unrivalled in antiquity, as philosophers, poets, artists, men of science, and men of action—nay, with all the added wisdom of nearly 2000 years we still bow reverently before the creations of their genius!

We find amongst the Romans the same attention paid to the strengthening and full development of the body in early life, the mental culture being deferred to a maturer age. With them, however, the education had a more exclusively warlike tendency; the system of public gymnasia did not exist, and their method of training was narrower in its aim, and less perfect in its details.

We find that the history of all ages and nations confirms that daily life, to be wise and good, must be the working out in detail of these universal laws. All the powers of our nature must be developed by exercise—but this development must be effected in the true order of growth; the double movement of body and soul must always be maintained, but with varying predominance according to the age; and every movement, every action, must have an object, a special and a universal use.

Such are the lessons we learn alike from the teaching of reason and the observation of life; and by our neglect of these principles we learn the cause of our present failure in the attainment of health—health in its widest sense.

Let us consider, then, in what way we can so far modify the education of the young, that it may be in accordance with those Divine laws which we now violate. A momentous question! We have done much to answer it, however, in attaining a clear understanding of the evil, which will serve to show us in what direction our efforts must be turned. In considering this question still farther, let me say a few words in relation to this important point—physical exercise—which, as we have seen, must play so prominent a part in true education.

Exercise, to perform its true work in the education of youth, must be scientific—its practice must be based on principles, it must accomplish definite ends by intelligent means; there is as much difference between the action of *thinking and unthinking muscles*, as between the idle jingling of tunes on the piano, by a person of quick musical ear, and the grand effects produced by an accomplished musician, who, expressing every faculty of his soul through his instrument, can carry his audience with him through the wide range of passionate sentiment.

The savage nations gain health and strength by their untutored activity, but they remain brutal and degraded—they gain no mental refinement by their exercises, and they are always surpassed by civilized man when he turns his attention to these subjects—as the Mormons, while journeying through the wilderness, always triumphed over their Indian antagonists in every encounter of force or skill, in running, leaping, wrestling, &c.

Now scientific exercise trains the mind and the character; it may be moral and intellectual in its action—the faculties of order, precision, calculation, self-command, decision, energy, &c., will be called into intelligent action through the exercise of the muscles; and by the combination of the senses with special adaptations of the muscles, a wide range of culture is opened to youth, which will embrace almost every instruction suitable to that age.

We are indebted to the Swedish poet and philosopher, Ling, for the noblest development of the subject of exercise which we have yet had; a student of the old Greek gymnastics, a descendant of the warlike Norsemen, surrounded by the traditions of their strength, their matchless feats of physical power, and the virtues that underlay their ferocity, he longed to introduce into our effeminate manners a little of the wholesale physical energy which seemed to have vanished with the old vikings. Thus he developed his admirable systems of gymnastics in its various branches; he saw it adopted by his native country—taken under the protection of the government—introduced into the army, into medicine, into education—and he left it as a precious legacy

to future ages, and to more detailed development and adaptation by his successors. To the zeal of his intelligent disciple, Professor Georgii, we owe the introduction of this system amongst the Anglo-Saxon race.

The system of Ling is an attempt to restore education to its true basis, and to attain the due balance between the physical and spiritual natures. It is not an effort to revive the heathen education of Greece, nor the fierce customs of the Northmen, but to adapt the principle of truth and vigour which existed in those people to the customs of our advanced civilisation—to join the physical energy of the Norsemen with the mental energy of the nineteenth century, and with the purity and holiness of the Christian.

In accordance with his views, as a first step in direct physical education, the will must obtain perfect control over all the muscles. You will remember the immense number of muscles in the human body, with the infinite variety of combinations of which they are capable. The ordinary exercise of walking and domestic occupations does not bring the majority of these muscles into active play; we need, then, special movements, which shall produce this wide activity, and thus strengthen every muscle and place it under the control of our will; the direction of these movements needs much physiological study, that there may be no violation of the laws of our economy, that true movements may be produced in a true way. Without this knowledge, gymnastic movements may become injurious, even dangerous; for not only may the muscles be injured by an attempt to perform movements for which they are not adapted, but their action may be falsified by an incorrect and slovenly manner of performing the movements.

EXCELLENCE is never granted to man but as the reward of labour. It argues indeed no small strength of mind to persevere in habits of industry without the pleasure of perceiving those advances, which, like the hand of a clock, whilst they make hourly approaches to their point, yet proceed so slowly as to escape observation.—*Sir J. Reynolds.*

HOW TO USE THE MICROSCOPE.

SIR DAVID BREWSTER gives the following rules for microscopic observations.

1. The eye should be protected from all extraneous light, and should not receive any of the light which proceeds from the illuminating centre, except what is transmitted through or reflected from the object. This rule will illustrate the use of the diaphragm under the stage of the microscope.

2. Delicate observations should not be made when the fluid which lubricates the cornea of the eye is in a viscid state.

3. The best position for microscopic observations is when the observer is lying horizontally on his back. This arises from the perfect stability of the head, and from the equality of the lubricating film or fluid which covers the cornea. The worst of all positions is that in which we look downwards vertically. The most common and easy position is generally with the instrument inclined at an angle of 45 degrees.

4. If we stand straight up and look horizontally, parallel markings or lines will be seen most perfectly when their direction is vertical; viz., the direction in which the lubricating fluid descends over the cornea.

5. Every part of the object should be excluded, except that which is under immediate observation.

6. The light which illuminates the object should have a very small diameter. In the daytime it should be a single hole in the window-shutter of a darkened room, and at night an aperture placed before an Argand lamp.

7. In all cases, particularly when high powers are used, the natural diameter of the illuminating light should be diminished, and its intensity increased, by optical contrivances.

The following remarks by Mr. James Smith, copied from the "Microscopic Journal," Vol. I., are recommended to the consideration of all who are in the habit of using microscopes. "Much of the beauty of the objects seen depend upon the management of the light that is thrown upon or behind them, which can only be fully mastered by practice. It

may be remarked, however, as a general rule, that in viewing those which are transparent, the plane mirror is most suitable for bright daylight, the concave for a lamp or candle, which should have the bull's-eye lens, when that is used, so close to it that the rays may fall nearly parallel on the mirror. If the bull's-eye lens is not used, the illuminating body should not be more than five or six inches from the mirror. The latter is seldom required to be more than three inches from the object, the details of which are usually best shown when the rays from the mirror fall upon it before crossing, and the centre should (especially by lamp-light) be in the axis of the microscope. For obscure objects, seen by transmitted light, and for outline, a full central illumination is commonly best, but for seeing delicate lines, like those on the scales of insects, it should be made to fall obliquely, and in a direction at right angles to the lines to be viewed.

"The diaphragm is often of great use in modifying the light, and stopping such rays as would confuse the image (especially with low or moderate powers); but many cases occur when the effects desired are best produced by admitting the whole from the mirror.

"If an achromatic condenser is employed instead of the diaphragm, its axis should correspond with that of the body; and its glasses, when adjusted to their right place, should show the image of the source of artificial light, or, by day, that of a cloud or window bar in the field of the microscope, while the object to be viewed is in focus.

"The most pleasing light for objects in general, is that reflected from a white cloud on a sunny day; but an Argand's lamp or wax candle, with the bull's-eye lens is a good substitute.

"A large proportion of opaque objects are seen perfectly well (especially by daylight) with the side reflector, and the dark box as a background; and for showing irregularities of surface, this lateral light is sometimes the best; but the more vertical illumination of the Lieberkuhn is usually preferable, the light thrown up to it from the mirror below being, with good management, susceptible of much command and variety."

NATURAL PHILOSOPHY.

CHAPTER V. (*Continued.*)

A barometer kept in the same place undergoes variations of altitude, some of which are regular, and others irregular. The former, which depend on diurnal tides in the atmosphere, analogous to tides in the sea, occur about the same time of the day—the greatest depression being commonly about four in the morning and evening, and the greatest elevation about ten in the morning and night. In summer, however, they occur an hour or two earlier in the morning, and as much later at night. The irregular changes depend on meteorological causes, and are not reduced as yet to any determinate laws. In amount they are much more extensive than the former, extending from the twenty-seventh to more than the thirtieth inch, while those are limited to about the tenth of an inch.

A very valuable application of the barometer is for the determination of accessible heights. The principle upon which this depends is simple—the barometer necessarily standing at a lower point as it is carried to a higher position. In practice it is more complicated, and to obtain exact results various methods have been given by Laplace, Bailly, Littrow, and others.

[The pressure of the atmosphere varies according to the elevation above the level of the sea, and on this principle the height of mountains is estimated. Supposing the density of the atmosphere to be uniform, a fall of one inch in the barometer would correspond to 11,065 inches, or 922 feet of air; but in order to make the calculation with accuracy, allowance must be made for the increasing rarity of the air, and for various other circumstances which are detailed in works on meteorology.—*Turner's Elements of Chemistry*, 6th. Edition, p. 263.]

CHAPTER VI.

THE PRESSURE OF THE AIR.

Measure of the Force with which the Air presses—Different Modes of Estimating it—Experiments Illustrating this Force—Elasticity of the Air—Experimental Illustrations—The Condenser.

HAVING explained the cause, and illustrated the pressure of the air, we proceed in the next place to determine its actual amount.

There are many ways in which this may be done. The following is simple: Take a pair of Magdeburgh hemispheres, the area of the section of which has been previously determined in square inches; exhaust them as perfectly as possible at the pump; and then, fastening the lower handle, *a*, to a firm support, hang the other, *b*, Fig. 25, to the hook of a steelyard, and move the weight until the hemispheres are pulled apart. It will be found that this commonly takes place when the weight is sufficient to overcome a pressure of fifteen pounds on every square inch.

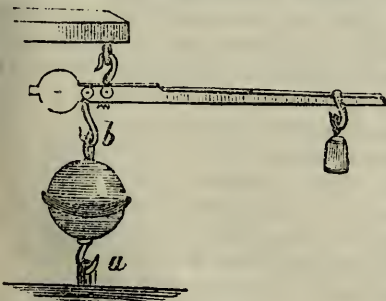


Fig. 25.

This may serve as an elementary illustration, but there are other methods much more exact. Thus, by the barometer itself we may determine the value of the pressure with precision. If we had a barometer which was exactly one square inch in section, and weighed the quantity of mercury it contained at any given time, it would give us the

value of the atmospheric pressure on one square inch, because the weight of the mercury is equal to the pressure of the air. And by calculation we can, in like manner, obtain it from tubes of any diameter.

The phenomena of the barometer teach us that this pressure is not always the same, but it undergoes variations. It is commonly estimated at fifteen pounds on the square inch.

[The pressure of the atmosphere being about fifteen pounds on every square inch, the surface of the whole globe sustains a pressure of 11,449,000,000 hundreds of millions of pounds. Shell-fish, which have the power of producing a vacuum, adhere to the rocks by a pressure of fifteen pounds upon every square inch of contact."—*Somerville's "Connection of the Physical Sciences," 7th Edition, page 126.*]

There are two other ways in which the value of the pressure of the air is stated. It is equal to a column of mercury thirty inches in length, or to a column of water thirty-four feet in length.

We are now able to understand the reason of the great effects to which the pressure of the air may give rise. In most instances these effects are neutralized by countervailing pressures. Thus, the body of a man of ordinary size has a surface of about two thousand square inches, the pressure upon which is equal to thirty thousand pounds. But this amazing force is entirely neutralized, because, as we have seen, the atmospheric pressure is equal in all directions, upward, downward, and laterally. All the cavities and the pores of the body are filled with air, which presses with an equal force. [What a fortunate thing it is that we are subjected to this apparent enormous pressure, for if this did not exist, the fluids that circulate within our bodies would be vapourised, and the surrounding parts crumble away.]

The following experiments may further illustrate the general principle of atmospheric pressure:

On a small flat plate, *a*, Fig. 26, furnished with a stop-cock, *b*, which terminates in a narrow pipe, *c*, let there be placed a tall receiver from which the air is to be exhausted by the pump. The stop-cock, *b*, being closed, and the instrument being removed from the pump, *b* is to be opened, while the lower portion of its tube dips into a bowl of water. Under these circumstances the water is pressed up in a jet through *c*, and forms a fountain in vacuo.

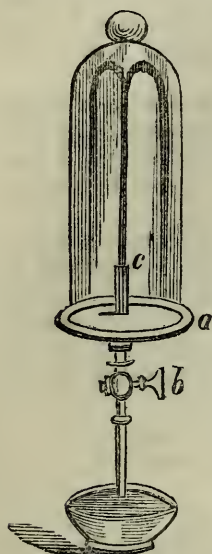


Fig. 26.

On the top of a receiver, Fig. 27, let there be cemented, air-tight, a cup of wood, *a*, terminating in a cylindrical piece, *b*, the pores of which run lengthwise. Beneath this let there be placed a tall jar, *c*. Now, if the wooden cup be filled with quicksilver, the jar being previously placed on the pump, and exhaustion made, the metal will be pressed through the pores of the wood and descend in a silver shower. The jar, *c*, should be so placed as to prevent any of the quicksilver getting into the interior of the pump.

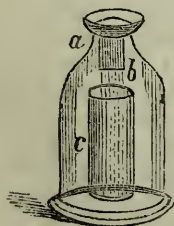


Fig. 27.

water, invert it in a jar, *B*; introduce into it now a little sulphuric ether, which will rise, because of its lightness, to the top of the tube, at *a*. Place the apparatus beneath the receiver of the air-pump, and exhaust. The ether will now be seen to abandon the liquid, and assume the gaseous form, filling the entire tube and looking like air. On allowing the pressure again to take effect, it again relapses into the liquid form.

The following experiments illustrate the elasticity of the air:



Fig. 28.

Take a glass bulb, *a*, Fig. 29, which has a tube, *b*, projecting from it, the open extremity of which dips beneath some water in a cup, *c*; the tube and the bulb being likewise full of water, except a small space which is occupied by a bubble of air at *a*. Invert over the whole a jar, *d*, and, placing the arrangement on the pump, exhaust. It will be found, as exhaustion goes on, that the bubble, *a*, steadily increases in size until it fills all the bulb, and even the tube. On readmitting the pressure, the bubble collapses to its original size. The air is, therefore, dilat-able and condensible—that is, it is elastic.

If a bottle, the sides of which are square and the mouth hermetically closed, be placed beneath a receiver, and the pressure removed, the air in the interior, exerting its elastic force, will violently burst the bottle to pieces. It is, therefore, well to cover it with a wire cage, as represented in Fig. 30.



Fig. 30.

The elastic force of the air increases with its density. Powerful effects, therefore arise by condensing air into a limited space. The condenser, which is an instrument for this purpose, is represented in Fig. 31. It consists of a tube, *a b*, in which there moves by a handle, *g*, a piston, *f*. In one side of the tube, at *c*, there is an aperture, and at the lower part, *d*, there is a valve, *e*, opening downward. On pushing the piston down, the air beneath it is compressed, and, opening the valve, *e*, by its elastic force, accumulates in the receiver, *R*. When the piston is pulled up, a vacuum is made in the tube; but as soon as it passes the aperture, *c*, the air rushes in. Another downward movement drives this through the valve into the receiver, and the process may be continued until the elastic force of the included air becomes very great.

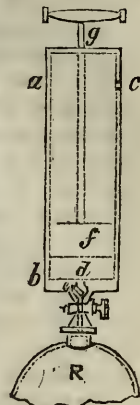


Fig. 31.

If the receiver be partly filled with water, and there be placed in it a piece of wax, an egg, or any yielding or brittle bodies, it will be found impossible to alter their figure by condensing the air to any extent whatever. And this arises from the circumstance already explained—that the pressure generated is equal in all directions.

[A common toy, known by the name of the water-balloon, is constructed upon the following scientific principles:—the figure of a balloon is blown in glass, and the lower part, which is curved for the car to be attached, has a small hole in it. A car is then suspended to it, and this is of such a weight that it is *exactly* balanced by the balloon full of air placed in a tall vessel of water, covered with a piece of bladder or India-rubber, which is firmly tied over the top. By pressing the finger on the cover, the balloon will descend to the bottom, and on removing the finger, the elastic force of the air in the balloon drives out the excess of water which had previously entered, and the balloon becoming lighter, reascends. Therefore, we say that the ascent and descent of the balloon depends upon the condensation and expansion of the air contained in it.—W. T. K.]

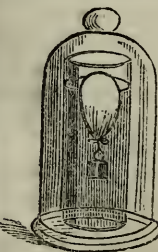


Fig. 32.

On precisely the same principle, if a small bladder, only partly full of air, be sunk by a weight, Fig. 32, to the bottom of a deep glass of water, on covering the whole with a receiver and exhausting, the elastic force of the included air dilates the bladder, which rises to the top, carrying with it the weight. When the pressure is readmitted, the bladder collapses and descends again to the bottom of the jar.

There are numerous machines in which the elastic force of air is brought into operation, such as the air-gun, blowing-machines, &c. Indeed, the various applications of gunpowder itself depend on this principle—that material on ignition suddenly giving rise to the evolution of an immense quantity of gas, which exerts a great elastic force.

CHAPTER VII.

PROPERTIES OF THE AIR.

Marriott's Law.—Proof for Compressions and Dilatations.—Case in which it Fails.—Resistance of the Air to Motion.—The Parachute.—The Air transmits Sound; supports Animal Life, Combustion, and Ignition.—Exists in the pores of some Bodies and is dissolved in others.

ATMOSPHERIC air being thus a highly compressible and expansible substance, we have next to inquire what is the amount of its compressibility under different degrees of force? This has been determined experimentally by different philosophers, the true law having first been discovered by Boyle and Mariotte.

The density and elasticity of air are directly as the force of compression.

The volume which air occupies is inversely as the pressure upon it.

To illustrate, and at the same time to prove these laws, we make use of a tube, *a d c b*, so bent that it has two parallel branches, *a* and *b*. It is closed at *b*, and has a funnel-mouth at *a*. Sufficient mercury is poured into the tube to close the bend and to insulate a volume of air in *b d*. Of course this air exists under a pressure of one atmosphere equal to a column of mercury thirty inches long. Through the funnel, *a*, mercury is now to be poured; as it accumulates it presses on the air in *d b*, and reduces its volume to *c*. If, in this manner, a column thirty inches long be introduced, it will be found that the air in *b d* is reduced to half. There are, therefore, now two atmospheres pressing on the included air—the atmosphere itself being one, and the thirty inches of mercury the other. Two atmospheres, therefore, reduce a given quantity of air into half its volume.

In the same manner it could be proved, if the tube were long enough, that the introduction of another thirty inches of mercury, giving a pressure of three atmospheres, would condense the air to one-third, that four would compress it to one-fourth, five to one-fifth, &c.

[The truth of this law may be proved for rarefactions as well as condensations.

Arago and Dulong have demonstrated that Mariotte's law does not vary for atmospheric air in its application to a pressure of twenty-seven atmospheres.—W. T. K.] For this purpose let there be taken a long tube, *a b*, Fig. 34, open at the end, *b*, and closed at *a*, with a screw; a jar, *B* filled with mercury to a sufficient height, is also to be provided. Now let the screw at *a* be opened and the tube depressed in the mercury until the metal, by rising, leaves in the tube a few inches of air. The screw is now to be closed and the tube lifted. The included air at once dilates, and a column of mercury is suspended. It will be found that when the air has dilated to double its volume, the length of the mercurial column *B* in the tube will be fifteen inches—that is, half the barometric length.

By such experiments it therefore appears that Mariotte's law holds both for condensations and rarefactions. This law has been verified until the air has been condensed twenty-seven times and rarefied one hundred and twelve times. In the case of gases, which easily assume the liquid form, it is, however, departed from as that point is approached.

Besides the properties already described, atmospheric air possesses others which require notice. Among these may be mentioned its resistance to motion.

This property may be exhibited by means of the two wheels, *a b*, Fig. 35, which can be put in rapid rotatory motion by the rack, *d*, which moves up and down through an air-tight stuffing-box, *e*. The wheels are so arranged that the vanes of *a* move through the air edgewise, but those of *b* with their broad faces. On pushing down the rack, *d*, and making the wheels rotate with equal rapidity in the atmospheric



Fig. 33.

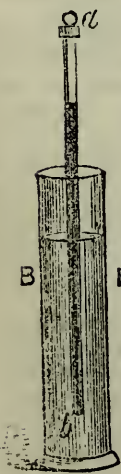


Fig. 34.

air, one of them, *a*, will be found to continue its motion much longer than the other, *b*; and that this arises from the resistance which *b* experiences from the air is proved by making them rotate in the receiver from which the air has been exhausted, when *b* will continue its motion as long as *a*, both ceasing to revolve simultaneously.

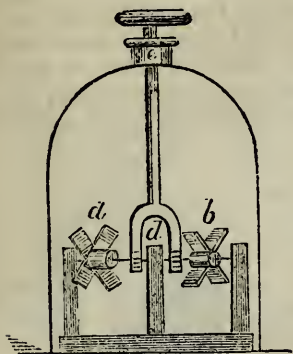


Fig. 35.

the closed end.

The parachute is a machine by which aëronauts may descend from a balloon to the ground in safety.

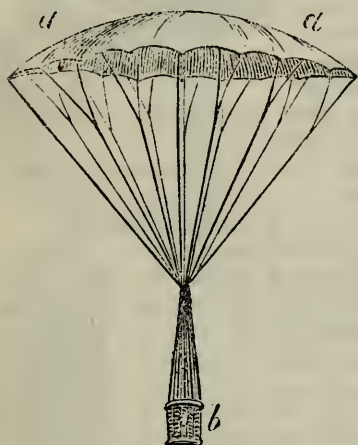


Fig. 36.

It bears a general resemblance to an umbrella, and consists of a strong but light surface, *a a*, Fig. 36, from which a car, *b*, is suspended.

When it is detached from the balloon, it descends at first with an accelerated velocity; but this is soon checked by the resistance of the air, and the machine then falls at a rate nearly uniform, and very moderate.

[A very simple experiment will enable

any person to illustrate the principle of the parachute. Take a piece of paper about three feet square, and attach a piece of thread to each corner of it; then fasten a proportionate weight to the lower part, as in Fig. 37, and let it drop from a window, or even from your hand, held as high as you can. It will descend slowly to the ground.—W. T. K.]

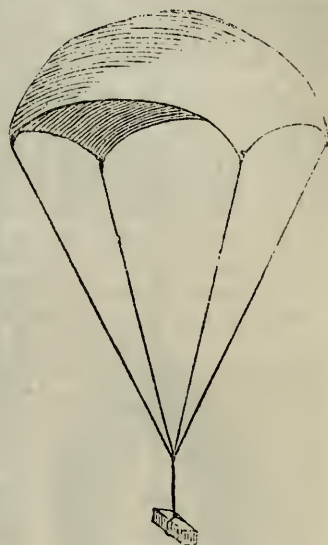


Fig. 37.

[Zacharia of Rosleben conceived that it would be possible to construct a flying boat, and, as an experiment, he made a case of light wood, covered with linen, in the shape of a flat obtuse-angled keel, five and a half feet in diameter, and half a foot deep, weighing fourteen and a half pounds. He launched this machine from a scaffold twenty-seven feet high, which was erected on a rock one hundred feet above the race-course of Wendelstein, upon the 17th of September 1822, and the boat flew 153 feet. He made another experiment upon the same day, and from the same spot, with another boat, weighing twenty-five pounds, which landed after a flight of 158 feet. The experiments were not repeated on account of the expense and their partial failure.—Abridged from the "Elements of Nat. Philosophy" by Prof. Viest, of Anhalt-Dessau, p. 208.]

In virtue of its elasticity, atmospheric air is the common medium for the transmission of sounds. Under the receiver of an air-pump, let there be placed a bell, *a*,

Fig. 38, the hammer, *b*, of which can be moved on its pivot, *c*, by means of a lever, *h*, which is worked by a rod passing through the stuffing-box, *e*. The bell is placed on a leather drum, *f*, and fastened down to the pump-plate by means of a board, *d*. While the air is yet in the receiver, the sound is quite audible, but on exhausting, it becomes fainter and fainter, and at last can no longer be heard. On readmitting the air the sound gradually increases, and at last acquires its original intensity. The leather cushion, *f*, is necessary to prevent the transmission of the sound through the solid part of the pump.

The air also is absolutely necessary for the support of life. The higher warm-blooded animals die when the air is only partially rarefied. A rabbit, or other small animal, placed

under an air-pump jar may remain there several minutes without being much disturbed; but if we commence withdrawing the air the animal instantly shows signs of distress, and if the experiment is continued, soon dies. (Fig. 39.)

So, too, if a jar containing some small fishes be placed under an exhausted receiver, the animals either float on their backs at the surface of the water; or descend only by violent muscular exertions. Fishes respire the air which is dissolved in water, and hence it is somewhat remarkable that they continue to live for a considerable length of time in an exhausted receiver.

The air is also necessary to all processes of combustion. If a lighted candle be placed under a receiver, it will burn for a length of time; but if the air be withdrawn by the pump, it presently dies out. The smoke also descends to the bottom of the receiver, there being no air to buoy it up.

If a gun-lock be placed in an exhausted receiver, and the flint be made to strike, no sparks whatever appear; and, consequently, if there were powder in the pan, it could not be exploded. The production of sparks by the flint and steel is due to small portions of the latter which are struck off by the percussion burning in the air, and when the air is removed that combustion can of course no longer take place. (Fig. 40.)

By taking advantage of the expansibility of the air, we are able to prove that it is included in the pores of many bodies.

Thus, if an egg is dropped into a deep jar of water, and this covered with a receiver, as soon as exhaustion is made, a multitude of air bubbles continually ascend through the water. (Fig. 41.) Or if a glass of porter be placed beneath such a receiver, its surface is covered with a foam, the carbonic acid gas, which is the cause of its agreeable briskness, escaping away. (Fig. 42.) And even common river or spring water treated in the same manner exhibits the escape of a considerable quantity of gas, which ascends through it in small bubbles, and gives it a sparkling appearance.

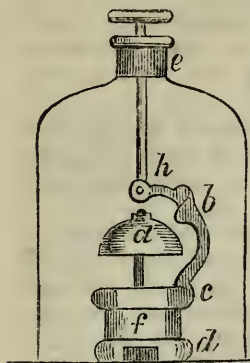


Fig. 38.

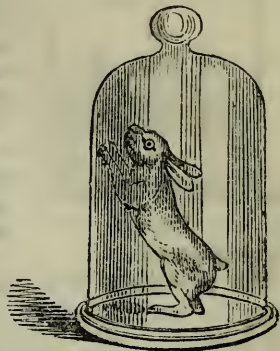


Fig. 39.

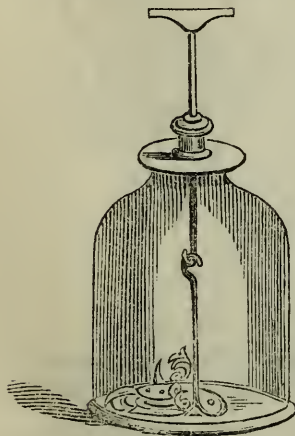


Fig. 40.



Fig. 41.



Fig. 42.

CHAPTER VIII.

PROPERTIES OF THE AIR.

Loss of Weight of Bodies in the Air.—Theory of Aërostation.—The Montgolfier Balloon.—The Hydrogen Balloon.—Mode of Controlling Ascent and Descent.—Artificial and Natural Currents in the Air.—Resistance of the Air to Projectiles.—Velocity with which Air flows into a Vacuum.—Velocity of Efflux of different Gases.—Principles of Gaseous Diffusion.—These Principles regulate the Constitution of the Atmosphere.

ON principles which will be fully explained when we come to speak of specific gravity, it appears that a solid immersed in a fluid loses a portion of its weight. It follows, of course, that a substance weighs less in the air than it does in vacuo.

To the arm of the balance, *a*, Fig. 43, let there be hung a light glass globe, *c*, counterpoised in the air on the other arm, *b*, by means of a weight, *d*. If the apparatus be placed beneath a receiver, and the air exhausted, the globe, *c*, descends, but on re-admitting the air the equilibrium is again restored. This instrument was formerly used for determining the density of the air.

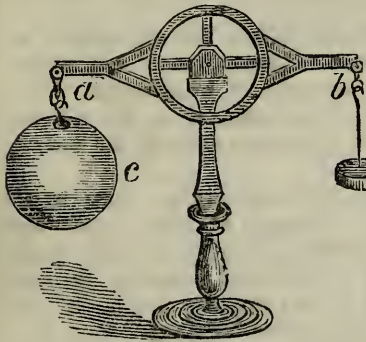


Fig. 43.

water. And as the density of the air continually diminishes as we go upward, it is evident that such a body, ascending from one stratum to another, will finally attain one having the same density as itself, and there it will remain suspended.

On these principles aërostation depends. Air balloons are machines which ascend through the atmosphere and float at a certain altitude. They are of two kinds: 1st, Montgolfier or rarefied air balloons; and 2nd, Hydrogen gas balloons.

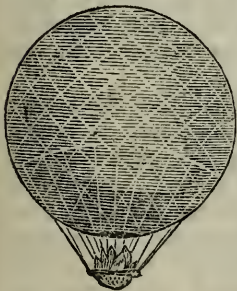


Fig. 44.

The Montgolfier balloon, which was invented by the person whose name it bears, consists of a light bag of paper or cotton, which may be of a spherical or other shape; in its lower portion there is an aperture, with a basket suspended beneath for the purpose of containing burning material, as straw or shavings. On a small scale, a paper-globe two or three feet in diameter, with a piece of sponge soaked in spirits of wine, answers very well. The hot air arising from the burning matter enters the aperture, distending the balloon, and makes it specifically lighter than the air, through which, of course, it will rise. (Fig. 44.)

The hydrogen gas balloon consists, in like manner, of a thin, impervious bag, filled either with hydrogen or common coal gas. The former, as usually made, is from ten to thirteen times lighter than air; the latter is somewhat heavier. A balloon filled with either of these possesses, therefore, a great ascensional power, and will rise to considerable heights. Thus, Biot and Gay Lussac, in 1804, ascended in one of these machines to an elevation of 23,000 feet. When the balloon first ascends, it ought not to be full of gas, for as it reaches regions where the pressure is diminished, the gas within it is dilated, and though flaccid at first, it will become completely distended. [A balloon which is only half full at the surface of the earth, becomes quite full when it has risen three miles and a half; because at that altitude, air from below doubles its volume on account of the diminished pressure.—Dr. Arnott's "Elements

of Physics." 3rd. ed. p. 401.]—If it were full at the time it left the ground, there would be risk of its bursting open as it arose. The gas balloon requires a valve placed at its top, so that gas may be discharged at pleasure, and the machine made to descend. The *aéronaut* has control over its motions by taking up, with him a quantity of sand in bags, as ballast. If he throws out sand, the balloon rises, and if he opens the valve, and lets the gas escape, it descends.

The rarefaction which air undergoes by heat makes it, of course, specifically lighter. Warm air, therefore, ascends, and cold air descends. When the door of a room, which is very warm, is open, the hot air flows out at the top, and the cold enters at the floor; these currents may be easily traced by holding a candle near the bottom and top of the door. In the former position the flame leans inward, in the latter it is turned outward, following the course of the draught.

The drawing of chimneys, and the action of furnaces and stoves, depends on similar principles; the column of hot air contained in the flue ascending, and cold air replacing it below.

Similar movements take place in the open atmosphere. When the sun shines on the ground or the surface of the sea, the air in contact becomes warm, and rises; it is replaced by colder portions, and a continuous current is established. The direction of these currents is changed by a variety of circumstances, as the diurnal rotation of the earth and other causes less understood. On these depend the various currents known as breezes, trade-winds, storms, hurricanes.

The atmosphere does not rush into a void space instantaneously; but, under common circumstances of density and pressure, with a velocity of about 1,296 feet in one second. Its resisting action on projectiles moving through it with great velocities is intimately connected with this fact. A cannon-ball, moving through it with a speed of two or three thousand feet, leaves a total vacuum behind it, and condenses the air correspondingly in front. It is, therefore, subjected to a very powerful pressure continually tending to retard it. [Though we should be led, as in hydraulics, to conclude that the resistance which air makes to moving bodies is as the square of their velocities, experiment appears to prove, especially when the velocity is great, that the resistance is partly proportional to the square, and partly to the simple power of the velocity.—Playfair's "Nat. Philosophy." Vol i. p. 276.] The rush of the air flowing into the vacuous spaces left by moving bodies is the cause of the loud explosions they make.

When gases of different densities flow from apertures of the same size, the velocities with which they issue are different, and are inversely as the square roots of their densities. The lighter a gas is, the greater is its issuing velocity; and, therefore, hydrogen, which is the lightest body, moves, under such circumstances, with the greatest speed.

The experiment represented in Fig. 45, illustrates these principles. Let there be a tube, *a b*, half-an-inch in diameter and six inches long, the end, *b*, being open and *a* closed with a plug of plaster of Paris, which is to be completely dried. Counterpoise this tube on the arm of a balance, and fill it with hydrogen gas, taking care to keep the plug dry, letting the open end, *b*, of the tube dip just beneath the surface of some water contained in a jar, *C*. In a very short time it will be discovered that the hydrogen is escaping through the plaster of Paris, and the tube, filling with water, begins to descend; and after a few minutes much of the gas will have gone out, and its place be occupied partly by atmospheric air, which comes in the opposite direction, and partly by the water which has risen in the tube.

(To be continued.)

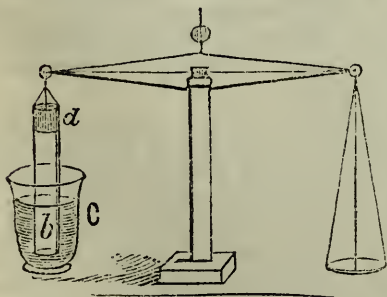


Fig. 45.

SYSTEM OF ELOCUTION.

(Continued from page 9.)

THE elements, as well as the letters by which they are represented, are usually divided into two classes, *Vowels* and *Consonants*. A more philosophical division, however, is into three classes, *Vowels*, *Subvowels*, and *Aspirates*.

The *vowels* are pure vocal sounds; their number is fifteen.

The *subvowels* have a vocality, but inferior to that of the vowels; their number is fourteen.

The *aspirates* are made with the whispering breath, and, consequently, have no vocality; they are nine in number.

CLASSIFICATION OF THE ELEMENTS.

Vowels.	English.	French.
ā as heard in	ale, day, fate, and in	été.
ā	arm, farm, ...	arme, gaz, gaze
ā	all, law, for, ...	—
ā	an, man, idea, ...	aller.
ē	eve, see, deed, ...	île.
ē	end, met, err, ...	elle.
ē	ile, fly, pine, ...	—
ē	in, pin, ...	il.
ō	old, no, more	eau.
ō	lose, too, move, ...	voûte.
ō	on, lock, not, ...	école.
ū	tube, few, pupil, ...	—
ū	up, her, hurt, ...	Europe.
ū	full, pull, wolf, ...	ou.
ou	our, now, flour, ...	—
Subvowels.		
b as heard in	bow, orb, barb	bon.
d	day, bid, did, ...	Dieu.
g	gay, fig, gig, ...	gai.
l	light, all, lull, ...	loup.
m	mind, storm, malm ..	mon.
n	no, on, nine, ...	non.
ng	song, think, ...	agneau (nearly)
r	roll, war, rare, ...	roue.
th	then, with, ...	—
v	vile, live, valve, ..	vil.
w	woe, went, world ..	oui (nearly).
y	yoke, yonder, ...	yacht.
z	zone, his, prism, ...	zone.
z̄	azure, enclosure, ...	jardin.
Aspirates.		
f as heard in	fame, if, drift, ...	femme.
h	hut, hence, ...	—
k	kite, wreck, kick, ...	cor.
p	pit, up, ...	papa.
s	sin, nice, crisp, ...	sœur.
sh	shade, push, flushed,	chaise.
t	tin, it, tart, ...	tour.
th	thin, truth, months,	—
wh	what, when, which,	—

The reader may ask why C, J, Q, and X, have not been classed with the elements. These letters have no sounds which are not represented, in the above scheme, by other letters. C has three sounds—the sound of *k*, as in *cat*; that of *s*, as in *cedar*, and that of *sh*, as in *ocean*. J expresses the combined sounds of *d* and *z* in *azure*. Q has the sound of *k*. X, as in *exercise*, expresses the combined sounds of *k* and *s*; in *example*, the combined sounds of *g* and *z* in *zone*; in *anxious*, the combined sounds of *k* and *sh*. In *Xenophon*, *x* has the sound of *z* in *zone*.*

The *Vowels*.—The vowels are divided into *Monothongs*, *Diphthongs*, and *Triphthongs*.

The *Monothongs* consist of one kind of sound throughout their concrete movement, and consequently are *simple* elements; they are represented by the italics in the following words: *arm*, *all*, *an*, *eve*, *end*, *in*, *on*, *up*, *full*.

The *Diphthongs* consist of two vowel sounds, which coalesce so intimately that they appear like one uniform sound; they are represented by the italics in the following words: *ale*, *île*, *lose*, *tube*.

The diphthong *ā*, as well as *ī*, has a characteristic sound for its radical, and the monothong, *ī*, for its vanish. These diphthongs, under certain circumstances (for instance, when they are carried through a wide range of pitch, as in interrogation with surprise), are converted into triphthongs, the third constituent being the monothong, *ē*.

The diphthong *ō*, as well as *ū*, has a characteristic sound for its radical and the subvowel *w*, for its vanish.

The *Triphthongs* consist of *three* vowel sounds which coalesce so intimately that they appear like one uniform sound; they are represented by the italics, in the following words; *old*, *our*.

The first constituent of *ō*, as well as that of *ou*, is a sound characteristic of this element; and the diphthong *ō*, constitutes the second and the third constituent of these triphthongs.

The following scheme is an analysis of

* X in *Xenophon* was pronounced by the ancient Greeks as we pronounce *x* in *exercise*, thus—*Xsenophon*; and I am informed by Mr. Castanis, a native of the island of Scio, that the modern Greeks so pronounce it.

the diphthongs and triphthongs. The reader will observe that the letters which are employed to represent the diphthongs and triphthongs, are used under the head, *constituents*, to represent their *radicals* only.

Diphthongs.	Constituents.	Triphthongs.	Constituents.
ā	ā — ī	ā*	ā — ī — ē
ī	ī — ī	ī*	ī — ī — ē
ō	ō — w	ō	ō — ō — w
ū	ū — w	ou	ou — ō — w

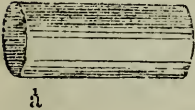
There is one diphthong and three triphthongs besides those already noticed; they are represented by the italics in the following words: *oil, ay, boy, buoy.*

But as all their constituents are to be found among the fifteen vowels before enumerated, they do not increase the number of the elements. This may be seen by the following analysis:

Diphthong.	Constituents.	Triphthongs.	Constituents.
oi	ā — ī	ay	ā — ī — ē
		oy	ā — ī — ē
		uoy	ō — ī — ē

During the utterance of a *monothong*, the aperture of the mouth remains stationary; but during that of a *diphthong* or *triphthong* the aperture is gradually diminished till the commencement of the last constituent; it then remains stationary till the sound is ended. This is illustrated by the following diagrams:

Diagram 1.



represents the aperture of the mouth in the utterance of the *monothong* ā, and the length of the tube represents the duration of the sound.

Diagram 2.



the aperture of the mouth in commencing the utterance of the diphthong ō—the portion of the figure between ō and w, shows the gradual diminution of the aperture of the mouth during the utterance of the first constituent, and the remaining portion shows the stationary position of the aperture of the mouth

during the utterance of the second constituent.

Diagram 3.



the aperture of the mouth in commencing the utterance of the triphthong ō—the portion of the figure between ō and ō, shows the gradual diminution of the aperture of the mouth during the utterance of the first constituent—the portion between ō and w, shows the gradual diminution of the aperture of the mouth during the utterance of the second constituent; and the remaining portion of the figure, the stationary position of the aperture of the mouth during the utterance of the third constituent.

The Subvowels.—B consists of a vocal sound and an aspirate. The first constituent is formed with the lips closed; the second, by aspirating the vowel ū, at the moment of their separation.*

When B is doubled, as in *rabbit*, the second constituent of the first B is omitted. When B is whispered, the second constituent only is heard. When words in which B is doubled are whispered, the first B is mute.

D consists of a vocal sound and an aspirate. The first constituent is formed with the tip of the tongue pressed against the gums of the upper incisory teeth; the second, by aspirating the vowel ū at the moment of its removal.*

When D is doubled, as in *addition*, the second constituent of the first D is omitted. When D is whispered, the second constituent only is heard. When words in which D is doubled are whispered, the first D is mute.

G consists of a vocal sound and an aspirate. The first constituent is formed with the root of the tongue pressed against the curtain, or veil of the palate; † the second, by aspirating the vowel ū at the moment of its removal. *

When G is doubled, as in *haggard*, the second constituent of the first G is omitted. When G is whispered, the second constituent only is heard. When words

* I have said that ā and ī are sometimes diphthongs; hence, above, they appear under both heads.

* Care should be taken not to make the second constituent *vocal*.
† In the language of anatomy, *velum pendulum palati*.

in which G is doubled are whispered, the first G is mute.

L is a vocal sound, made with the tip of the tongue pressed against the gums of the upper incisory teeth.

M is a nasal sound, made with the lips closed.

N is a nasal sound, formed with the tip of the tongue pressed against the gums of the upper incisory teeth.

NG, as in *song*, is a nasal sound, formed with the root of the tongue pressed gently against the curtain of the palate.

R is a vocal sound, of which there are two varieties. The first is called the *trilled R*, and is made by causing the tongue to vibrate against the gums of the upper incisor teeth, while the breath is propelled through the mouth; the second is called the *smooth R*, and is made with the tip of the tongue elevated towards the centre of the roof of the mouth. R should be trilled when it precedes a vowel, as in *roll*, *crush*, &c.; but when it follows a vowel, as in *air*, *orb*, &c., it should be made smooth.

I have met with a number of individuals who could not trill the R, and others who did it with difficulty. Those who cannot trill it in a graceful manner had better not attempt it in public; let such, however, not despair—their vocal organs may be rendered flexible by frequent and energetic exercise.

TH, as in *then*, is a compound of vocality and aspiration, formed with the tip of the tongue resting against the inner surface of the upper incisory teeth.

V is a compound of vocality and aspiration. It is formed with the under lip pressed against the edge of the upper incisory teeth.

W is a vocal sound, formed with the lips contracted as in the act of whistling.

Y is a vocal sound, formed with the lips and teeth a little separated.

Z, as in *zone*, is a buzzing sound, a compound of vocality and aspiration. It is formed by pressing the tip of the tongue gently against the gums of the upper incisors, and forcing out the breath.

Z, as in *azure*, is a compound of vocality and aspiration. It is formed with the tip of the tongue nearly in the same position as is *z* in *zone*, though drawn a little further back, and somewhat widened, so as

to enlarge the aperture formed by its upper surface and the roof of the mouth, through which the breath is forced.

The Aspirates.—F, like V, is formed with the under lip pressed against the upper incisory teeth.

H is the inceptive part of a vowel sound, aspirated in a particular way. H may be uttered in as many varieties of ways as there are vowels in the language; each requiring the same posture of the mouth, which the vowel itself requires.

K is formed by pressing the root of the tongue against the curtain of the palate, and then aspirating the vowel *û*. When this element is doubled, as in *fickle* (pronounced *fîk k l*) the first *k* is mute.

P is formed by closing the lips, and then aspirating the vowel *û*. When this element is doubled, as in *happy*, the first P is mute.

S is a hissing sound, and, like *z* in *zone*, is formed with the tip of the tongue pressed gently against the gums of the upper incisory teeth. It is nearly the same as *z* in *zone* aspirated.

SH is formed with the tongue in the same position as is *z* in *azure*. SH is nearly the same sound as *z* in *azure*, aspirated.

T is formed by pressing the tip of the tongue against the gums of the upper incisory teeth, and then aspirating the vowel *û*. When T is doubled, as in *attempt*, the first T is mute.

TH, as in *thin*, like *th* in *then*, is formed with the tip of the tongue pressed against the upper incisory teeth. It is nearly the same sound as the subvowel TH aspirated.

WH is the inceptive part of the vowel *û* aspirated in a particular way. The sound which is produced, in the formation of this element, is nearly the same as *hû*, whispered. WH requires the same posture of the mouth that the vowel *û* requires. That *hû* and *wh* are not identical, may be proved by pronouncing, alternately, the words *hoom* and *whoom*, and observing the contrast between them.

The Postures of the Mouth.—An accurate knowledge of the positions which the organs of articulation should assume in the formation of the several elements of vocal language, is very important to those who would speak with ease and elegance.

The pupil should exercise his organs of

speech, in the most forcible manner, three times a-week, and, if possible, even every day, on all the elements. The vowels should be exploded from the throat, both interrogatively and affirmatively, in every range of pitch within the compass of the voice, and with every possible degree of force.

The vowels are exploded in the following manner: make a full inspiration, close the glottis, and contract the muscles of expiration so as to condense the air in the lungs, then utter the element with a sudden and forcible emission of the breath. The sounds thus produced may be denominated *vocal thunder*; the effect upon an audience is electrical.

This exercise strengthens the vocal organs, and enables the speaker to be heard at a great distance, with very little effort, or expenditure of breath. It is also beneficial to health.

Defective Articulation.—Articulation is defective when one or more elements of a word are omitted or imperfectly formed; or when one element is substituted for another.

Defective articulation is exceedingly common: perhaps there is not one individual in ten thousand whose articulation is *perfect*. This arises from the neglect of a proper gymnastic training of the organs of speech in childhood. As soon as children are capable of imitating sounds, they should be taught the elements of vocal language; and, to facilitate their acquisition of this knowledge, they should be made to exercise before a mirror, so as to compare the movements of their own lips with those of the lips of their instructor. By pursuing this course, a good foundation will be laid for a perfect and graceful articulation.

In that part of our treatise which consists of EXERCISES IN READING AND DECLAMATION, all, or nearly all, the letters representing sounds liable to be omitted, or imperfectly articulated, will be italicised. Hence it is not necessary to furnish examples, and treat of the subject minutely in this place. There are, however, some instances of defective articulation which are not pointed out by the italic letters; these are so important that they deserve special notice. I allude to those cases in which one element is sub-

stituted for another. The remainder of this chapter will be devoted to their consideration.

Children are apt to substitute the sound of *d* for that of *g* in *gay*; and the sound of *t* for that of *k*, or *c* in *cat*. Thus, for *gay*, they say *day*; for *cake*, *tate*, &c.

To enable the pupil to correct these faults, I explain to him the manner in which the sounds of *g* and *k* are produced; they are formed by pressing the root of the tongue against the soft palate, and not, like *d* and *t*, by pressing its tip against the gums of the upper incisors. I then direct him to pronounce, after me, the elements, *d*, *g*, and *t*, *k*, and the syllables *da*, *ga*, and *ta*, *ka*, thus:—

d, *g*; *d*, *g*; *d*, *g*; *d*, *g*; *d*, *g*;
t, *k*; *t*, *k*; *t*, *k*; *t*, *k*; *t*, *k*;
d, *g*; *d*, *g*; *d*, *g*; *d*, *g*.
t, *k*; *t*, *k*; *t*, *k*; *t*, *k*.
dā, *gā*; *dā*, *gā*; *dā*, *gā*; *dā*,
tā, *kā*; *tā*, *kā*; *tā*, *kā*; *tā*,
gā; *dē*, *gē*; *dē*, *gē*; &c.
kā; *tē*, *kē*; *tē*, *kē*; &c.

The object of this exercise is to contrast the substituted sound with the correct one.

When this plan does not prove successful, I open my mouth as widely as possible, so that the tip of the tongue cannot touch the gums of the upper teeth, and request the pupil to open his in like manner. I then direct him to pronounce, after me, the following syllables:

gā, *gā*, *gā*, *gā*; *gē*, *gē*; *gī*, *gī*;
kā, *kā*, *kā*, *kā*; *kē*, *kē*; *kī*, *kī*;
gō, *gō*, *gō*; *gū*, *gū*, *gū*; *gou*.
kō, *kō*, *kō*; *kū*, *kū*, *kū*; *kou*.
āg, *ēg*, *īg*, *ōg*, *ūg*, *oug*; *āk*, *ēk*, *īk*, *ōk*, *ūk*,
ouk.

When neither of these schemes proves successful, I request the pupil to press his tongue downwards and backwards, with his index finger, while I do the same, and pronounce, after me, the syllables in the preceding exercise. This I have never known to fail.

Some children omit the element *z*, when it follows *d*, and the element *sh* when it follows *t*: for instance, they pronounce *John*, *don*, and *Charles*, *tarles*, &c.* My

* *J* is a compound of *d* and *z* in *azure*; and *ch* is equivalent to *tsh*.

method of correcting these defects is to contrast the false pronunciation with the true one, as in the following exercise:

dā, dā̃; dā̃, dā̃; dā̃, dā̃;
tā, tshā; tā, tshā; tā, tshā;
dā, dā̃; dē, dē̃; &c.
tā, tshā; tē, tshē; &c.

The *v* and *w* are confounded by some persons; for instance, when they would say *vine*, they say *wine*, and *vice versa*. An attention to the proper postures of the mouth, in the production of these elements, will soon enable the pupil to correct this fault. The following exercise, founded on the principle of contrast, should be frequently practised by the pupil in the most energetic manner:

vā, wā; vā, wā; vā, wā; vā,
wā, vā; wā, vā; wā, vā; wā,
wā; vē, vē; vē, vē; &c.
vā, vē, vē; vē, vē; &c.

In correcting faults in articulation, I often find it advantageous to exercise the pupil before a mirror, that he may observe the contrast between the movements of his own mouth, and those of mine.

Lisping.—*Lisping* is the substitution of the sound of *th* for that of some other letter, generally for that of *s* in *sin*. Thus the words, *sale*, *send*, *sight*, *song*, &c., are pronounced *thale* *thend*, *thight*, *thong*, &c.

The lisper should be told, that, in forming the sound of *th*, the tip of the tongue is pressed gently against the inner surface of the upper incisor teeth: whereas, in forming that of *s*, it is placed, in like manner, against the *gums* of the upper incisor teeth. Hence, to avoid making *th* for *s*, the tongue should be drawn back a little, and its point turned upward against the gums of the upper teeth. In the correction of lisping, the following exercise may be practised with advantage: thā, sā; thā, sā; thā, sā; thā, sā; thē, sē; thē, thē; &c.

The defects of articulation, in which one element is substituted for another, are numerous; but, as the method of treatment is similar in all, it is presumed enough has been said to enable the teacher to manage them successfully, particularly as appropriate exercises for most of them will be found in the *practical* part of this work.

CHEMISTRY.

(Continued from page 42.)

LIGHT.

THE various phenomena of light belong to the science of optics more properly than to chemistry; but a knowledge of some of its laws is, however, required of the chemical student, and the progress of discovery daily shows us some new connection between the phenomena of light and chemical action.

Sources and nature of Light.—The chief source of light is the sun, and besides this, we have many minor and artificial sources. There have been several theories advanced respecting the nature of light; but I believe that we do not know anything of its real nature. Sir Isaac Newton's theory, or, as it is called, the corpuscular theory of light, is not generally well received now, because it has been succeeded by the undulatory or wave theory of light. The latter is based upon the wave theory of sound, and it is argued that light is conveyed to the eye in like manner, that is, by a series of unending and inconceivably rapid pulsations or undulations, imparted from the source of light to a very rare elastic medium, which is supposed to fill all space, and is called the *luminiferous ether*.

Properties of Light.—1st. All luminous bodies transmit rays of light in all directions. 2nd. The light transmitted from luminous bodies will render more luminous bodies visible when it falls upon them. 3rd. The body transmitting the light also imparts its colour to the rays. 4th. Light consists of distinct parts independent of each other. 5th. Rays of light proceed in straight lines. 6th. The light is said to be transmitted 195,000 miles in a second of time.

When a ray of light falls upon the surface of any body, the following effects may be the result:—1st. It may be absorbed and disappear altogether. 2nd. It may be nearly all reflected. 3rd. It may pass through or be transmitted; and 4th. It may be partly absorbed, partly reflected, and partly transmitted. When bodies allow light to pass through them, they are said to be transparent, but when they intercept the light they are called

opaque. Translucent bodies allow some portion of light to pass through them, without, however, allowing the form or colour of objects to be distinguished.

Reflection.—Light is reflected according to a very simple law. In Fig. 3., if the ray of light fall from P' to P , it is thrown directly back to P' ; for this reason a person looking into a common mirror,

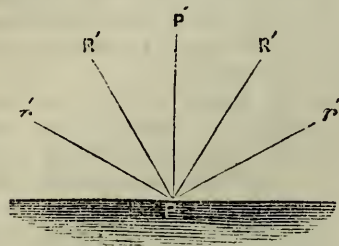


Fig. 3.

sees himself correctly, but his image appears to be as far behind the mirror as he is in front of it. If the ray fall from R to P , it will be reflected to R' , and if from r , then it will go in the line r' , and so for any other point. If we measure the angles RPP' and $P'PP'$, we shall find them equal to each other, and so also the angles rPP' and $P'PP'$. These angles are called respectively the angles of *incidence* and *reflection*. We therefore state that the angle of incidence is equal to the angle of reflection, which is the law of simple reflection. This law is as true of curved surfaces as it is of planes; for a curved surface (like a concave metallic mirror) is considered as made up of an infinite number of small planes.

Simple Refraction.—If a ray of light

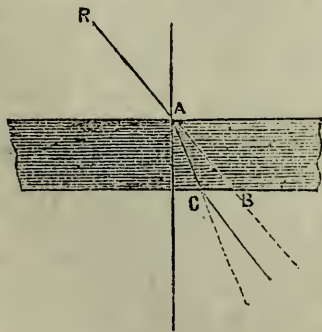


Fig. 4.

falls perpendicularly on any transparent or uncrystallized surface, as glass or water,

it is partly reflected, partly scattered in all directions (which part renders the object visible), and partly transmitted in the same direction from which it comes. If, however, the light come in any other than a perpendicular or vertical direction, as from R to A , on the surface of a thick slip of glass, as represented in Fig. 4, it will not pass the glass in the line RAB , but will be bent or *refracted* at A to C . As it leaves the glass at C , it again travels in a direction parallel to RA , its first course. *Refraction*, then, is the change of direction which a ray of light suffers on passing from a rarer to a denser medium, and the reverse. In passing from a rarer to a denser medium (as from air to glass or water), the ray is bent or refracted towards a line perpendicular to that point of the surface on which the light falls, and from a denser to a rarer medium the law is reversed.

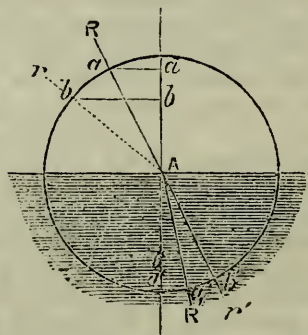


Fig. 5.

A common experiment, in illustration of this law, is to place a coin in the bottom of a bowl, so situated that the observer cannot see the coin until water is poured into the vessel; the coin then becomes visible, because the ray of light passing out of the water from the coin, is bent towards the eye. In the same manner, a straight stick or spoon thrust into water, appears bent at an angle where it enters the water.

Amount of Refraction.—The obliquity of the ray to the refracting medium determines the amount of refraction. The more obliquely the ray falls on the surface the greater the amount of refraction. A little modification of the last figure will make this clear. Let RA be a beam of light falling on a refracting medium, it is

bent as before to R' . If we draw a circle about A as a centre, and a line aa , from the point a where the circle cuts the ray R at right angles, to the perpendicular passing through A , the line aa is called the *sine of the angle of incidence*; while the line $a'a'$ is called the *sine of the angle of refraction*.

If a more oblique ray r , cuts the circle at b , the line bb will be longer than the line aa , inasmuch as the angle bAa , is greater than the angle aAa .

The line measuring the obliquity before refraction, when the ray passes into a denser medium, is always greater than that which measures it after, and is nearly one-third more in the case of water. This is called the *index of refraction*; the refractive power of water is expressed by $1\frac{1}{3}$ or 1.33, while common glass with a higher refractive power, has the index of refraction $1\frac{1}{2}$ or 1.5, and the diamond 2.239. In the larger works full tables will be found with the refractive indices of numerous substances.

Substances of an inflammable nature, or containing carbon, and those which are dense, have, as a general thing, a higher refracting power than others. Sir Isaac Newton observed that the diamond and water had both high refracting powers; and he sagaciously foretold the fact, which chemistry has since proved, that both these substances had a combustible base, or were of an inflammable nature. We now know that the diamond is pure carbon, and that water has hydrogen, a combustible gas, as one of its constituents.

Prism.—In the cases of simple refraction just explained, the ray, after leaving the refracting medium, goes on in a course parallel to its original direction, because the two surfaces of the medium are parallel. If, however, we employ a triangular glass prism like that in Fig. 6,



Fig. 6.

or any other surfaces not parallel, the ray will be diverted permanently from its original direction after leaving the prism. As already explained, the ray R is bent towards a perpendicular to the surface

(which is the dotted line), but on leaving the prism it is by the same law further refracted in the direction R' ; and by altering the form of surfaces we may thus send it in almost any direction, as in the common multiplying-glass, which gives as many images as it has faces, and all in different directions. In this way it is that concave metallic mirrors concentrate and convex ones disperse a beam of light.

Analysis of Light.—By means of the prism we learn that a beam of sunlight is not simple white light, but a compound of several colours, of the most vivid tints which can be imagined. We are indebted to Sir Isaac Newton for this beautiful experiment, which is called "Newton's Analysis of Light." A beam of sunlight from R , in Fig. 7, falling from a small circular aperture in the shutter of a darkened room on a common triangular prism, is refracted twice, and bent upward towards the white screen R' , placed



Fig. 7.

at some distance from the prism, where it forms an oblong coloured image, composed of seven colours. This image is called the *prismatic or solar spectrum*.

The light from flames of all kinds, the oxy-hydrogen blowpipe, and the electric spark, or galvanic light, is also compound in its nature, like that of the sun and other celestial bodies.

Prismatic Colours.—The colours of the solar spectrum are in the following order, upwards: red, orange, yellow, green, blue,

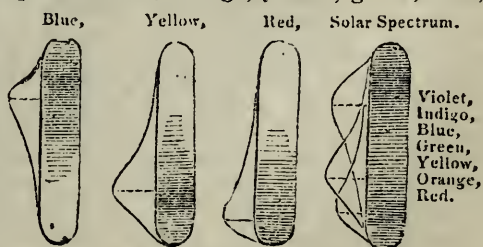


Fig. 8.

indigo, violet. These colours are of very different refrangibility, and for this reason are presented in a broad surface, the red being the least refracted, and the violet the most. The seven colours of Newton, it is believed, are really composed of the three primitive ones,—red, yellow, and blue. This idea is well expressed in Fig. 18. The three primitive colours each attain their greatest intensity in the spectrum at the points marked at the summit of the curves; while the four other colours, violet, indigo, green, and orange, are the result of a mixture in the spectrum of the other three. A portion of proper white light is also found in all parts of the spectrum, which cannot be separated by refraction. We may hence infer that there is a portion of each colour in every part of the spectrum, but that each is most intense at the points where it appears strongest. The light is most intense in the yellow portion, and fades towards each end of the spectrum.

Sir John Herschel has detected rays of greater refrangibility than the violet of the spectrum, which have a lavender colour. They have this colour after concentration, and are therefore not merely, as might be supposed, dilute violet rays.

If the spectrum is formed by a beam of light passing through a slit not over $\frac{1}{30}$ of an inch in width, the image will be crossed by a number of dark lines, which always appear in the same relative position. These are called the *fixed lines* of the spectrum, and are much referred to as boundary lines in optical descriptions. These lines can be transferred to the sensitive papers used in photography.

Natural Colour of Bodies.—The colour of bodies in Nature are due to the fact that their surfaces absorb all the light, except the colour we recognise as belonging to each object. This property is to be ascribed to some cause inherent in the nature of the substances.

Double Refraction.—The refraction which we have just considered belongs to all bodies which permit the passage of light. But in most crystalline substances, and all bodies having any regular internal structure, such as bone, shell, &c., there is another sort of refraction. By looking through such bodies in certain positions, two objects are seen instead of one, one

by the *ordinary*, and the other by an *extraordinary* ray.

This phenomenon is called *double refraction*, and is best seen in the mineral called calc spar, or Iceland spar, which, when pure, is colourless and transparent, and breaks into regular rhombs, with brilliant faces. If a rhomb of this mineral be laid over a black line, we see a double image, as if there were in reality two lines.* This direction of the ray is owing to the interior crystalline structure of the mineral. Of the two beams into which the light is divided, one obeys the law of refraction already explained, while the other pursues an entirely different course. One is called the ordinary, and the other the extraordinary ray.

Polarization.—The light which has passed one crystal of Iceland spar by extraordinary refraction, is no longer affected like common light. If we attempt to pass it through another crystal of the same substance, there will be no further subdivision, and only a greater separation of the two beams.

This peculiar physical change is called *polarization*, as the light is supposed to assume a polar condition. Many other mineral substances also polarize light when cut into thin plates. The mineral called tourmaline has this property in a remarkable degree. The internal structure of this mineral is such, that a ray of light can pass through thin plates of it in one direction, but not in another; as, for illustration, a thin blade may pass between

* A sharp line like, $p q$, when seen through a rhomb of calc spar in the direction of the ray $R r$, will seem to be double, a second parallel line $m n$, being seen at a short distance from it, and the dot o will have its fellow e . In this case the light is represented as coming from R to r , and passing through the crystal, it is split and emerges in two beams at e and o . The same effect would be produced if the light fell so as to strike any part of the imaginary plane $A C B D$, which diagonally divides the crystal, and is called its principal section. The axis or line drawn from A to B , is contained in this plane. But if we look through the crystal in a direction parallel to this plane ($A C B D$) there is only simple refraction, and only one line is seen.

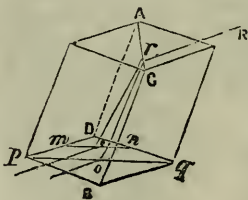


Fig. 9.

the wires of a cage if held parallel to the interstices, but will, of course, be arrested if turned at right angles to them.

In Fig. 10 we have two thin plates of tourmaline placed parallel to each other in the same direction. A ray of light passes through both in the direction of $R R'$, and apparently suffers no change: if, however, these plates are so placed as to cross each other at right angles, as in

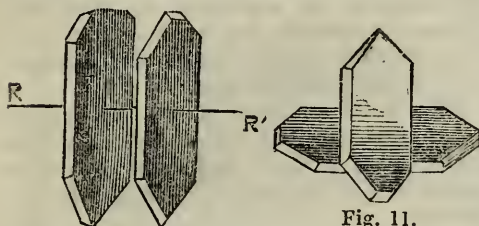


Fig. 10.

Fig. 11, the ray of light is totally extinguished; and four such points may be found in revolving one of the plates about the ray as an axis.

Light is also polarized when passed obliquely through a bundle of plates of thin glass, or mica, arranged as in the Fig. 12. The reflection of light from the surface of various substances is also

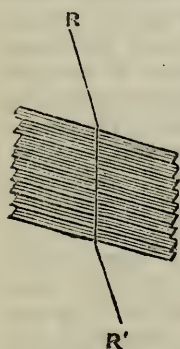


Fig. 12.

productive of polarization at an angle which is peculiar to each substance, and hence called the angle of polarization. This angle on glass is found to be $56^{\circ} 48'$. The phenomena of polarized light are among the most attractive and important in the science of optics, but their study would lead us away from our present object.

Chemical Rays.—Besides the rays of light in the solar spectrum which we have already noticed, and the rays of heat which we shall presently consider, there is still another class of rays, which, while they have a greater refrangibility than the violet, are also found by the delicate experiments of Herschel to be present in every part of the solar spectrum; they have been sometimes called the *chemical rays*, from the powerful effect which they pro-

duce in chemical combinations. They act in a manner altogether independent of the rays of heat. Chlorine and hydrogen gases are made to combine by them with explosive energy, while in diffuse light the union of these gases is slow and quiet.

Many metallic salts are changed to a darker colour by their action, as the chloride and iodide of silver, facts which have been beautifully applied in the arts of photography by sensitive papers, and of the daguerreotype. The last depends on the sensitiveness of the iodide of silver to the action of the chemical or more luminous rays of the sun. This power in the non-luminous rays has been variously designated by the terms *actinism*, *tithonicity*, and *energia*.

The accompanying diagram will enable

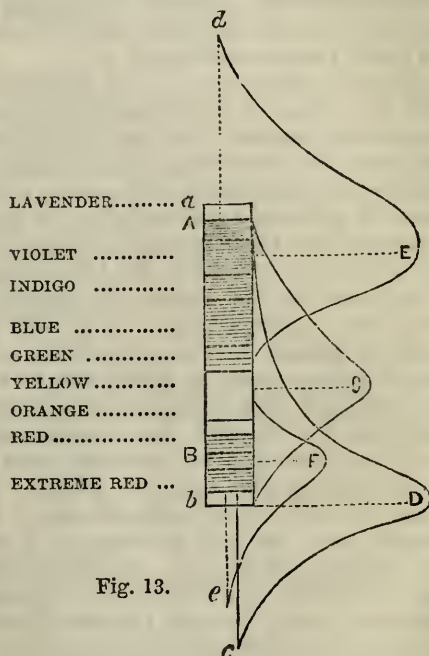


Fig. 13.

the student to obtain clearer views of our present knowledge in relation to this interesting subject, which has already made so many splendid presents to the arts. From A to B, we have the solar spectrum with the colours in the same order as already described. The greatest chemical power is at the violet, and the greatest heat at the red ray. At b another red ray is discovered, and at a is the lavender light. The luminous effects are shown by

the curved line C, the maximum of light being found at the yellow ray. The point of greatest heat is at D, beyond the red ray, and it gradually declines to the violet end, where it is entirely wanting, the other limit of heat being at *c*. The chemical powers are greatest about E, in the limits of the violet, and gradually extend to *d*, where they are lost. They disappear also entirely at C, the yellow ray, which is neutral in this respect, attain another point of considerable power at F, in the red ray, which gives its own colour to photographic pictures; and ceases entirely at *c*. The points D, C, E, therefore, represent respectively the three distinct phenomena of Heat, Light, and Chemical Power. This last is believed to be quite independent of the other powers; for all light may be removed from the spectrum, by passing it through blue solutions, and yet the chemical power remains unaltered.

Spectral Impressions.—In connection with the chemical properties of light, we mention the curious fact that bodies have the power of impressing their images or pictures on each other in the dark, or on plates of polished metal and glass, in such a manner that these become at once visible, if the bright surface be breathed on or exposed to the vapour of mercury, as in the daguerreotype. If a coin or medal is placed on a finely polished surface of sheet-copper or silver, and be left in a perfectly dark place for a few hours, (particularly if the plate has been warmed) it will be found that on breathing upon or mercurializing the metallic surface, an image of the object will at once be brought out, and can be renewed in the same manner indefinitely. It is supposed that this effect is owing to an invisible influence, passing between the two objects, and producing a change in the condition of the surface, or the arrangement of its particles. Engravings can be permanently copied in this way, and many curious and instructive experiments performed, which our space will not permit us to describe.

Phosphorescence is a property possessed by some bodies of emitting a feeble light, often at ordinary temperatures. The diamond and some other substances, after being exposed to the rays of the sun, will emit light for some time in the dark. Fluor-spar, feld-spar, and some other

minerals, give out a fine light of varied hues, when gently heated or scratched. Oyster-shells which have been calcined with lime and exposed to the sun-light, will shine in a dark place for a considerable time afterwards. The glow-worm, the fire-fly, rotten wood, decaying fish, and various marine animals, possess the same property in a greater or less degree.

This and similar facts have been made the basis of an argument by Professor Draper, to sustain the opinion that there is, in addition to light, heat, and electricity, a *fourth* imponderable agent.

This brief outline of the history of light must impress the belief that this agent holds a most important place in maintaining the physical welfare of our planet.

Plants, by aid especially of the yellow rays, transform the inorganic constituents of matter into living and growing organisms, which appropriate their food, decompose and recombine various compounds in a manner which the chemist can never hope to imitate.

PORCELAIN.—Porcelain, the name first applied to the fine earthenwares of China, is of Portuguese origin, from the word *porcellana*, a cup; the Portuguese traders being the first who introduced the beautiful Chinaware into England. It has been attempted to prove a different origin for the name, attributing this to the resemblance of the glazing or varnish, and probably the colours of porcelain, to those of the shells used in some parts of the world instead of money (cowries), and which, from the similarity of their shape to that of the back of a little pig, were also called *porcella*. The Chinese, who were in former times even more successful than they are at present in keeping a secret, contrived to conceal all knowledge of the manufacture of porcelain from the other nations of the earth; till, in the beginning of the eighteenth century, a cunning Jesuit, who was residing as a missionary in China, succeeded in eluding the jealous vigilance so generally practised towards strangers in that country, and not only obtained specimens of the earths used in the composition of their porcelain, but also some knowledge of the processes employed in its manufacture.

LESSONS IN FRENCH.

(Continued from page 43.)

GENDERS OF NOUNS, MOSTLY DEPENDING ON THEIR TERMINATION.

The names of fruits, grain, plants and flowers, generally take the gender of their

termination; there are, however, very many exceptions, which are too numerous to be mentioned here. The student, when in doubt, must consult his dictionary.

We will now give a table of all the masculine terminations, with the exceptions attached to each.

Number of words of the masculine gender.	Masculine.	Terminations.	Feminine	Number of words of the feminine gender.
	none.	tié	amitié, inimitié, moitié, pitié.	4
11	aparté, arrêté, bénédicité, comté	té	absurdité, beauté, charité, cité, dig-	500
40	côté, été, pâté, traité, thé, té, lété.	i	nité, fidélité, &c.	
15	alibi, biribi, lundi, grand-merci, &c.	oi	fourmi, merci, gaqui, après-midi.	4
30	convoi, effroi, &c.	o	foi, loi, paroi.	3
10	ergo, vertigo, indigo, &c.	u	albugo, virago.	2
200	fichu, ceru, écu, tissu, &c.	an	bru, gru, tribu, vertu.	4
6	aloyau, anneau, &c.	ef	eau, peau, surpeau, sans-peau.	3
3	bref, chales, chef, fief, relief, grief.	aim	clef, nef, soif.	2
100	daim, essaim, abatfaim.	an	faim, malfaim.	1
200	an, ban, cran, écran, &c.	in	maman.	3
	bain, baise-main, avant-main, garde-			
	main, tourne-main, essuie-main, grain,		fin, main, nonnain.	
	frein, &c.			
4	scion, bastion, bestion, ixion.	cion sion tion gion nion xion	succion, &c. cession, &c. gestion, friction, &c. région, &c. opinion, &c. réflexion, fluxion, &c.	1100
30	gabion, &c. bandion, &c. lion, &c. trémion, &c. espion, &c. septentrion, &c. gavion, &c.	bion dion lion maion pion rion vion	rébellion, dent-de-lion.	3
8	aleyon, clayon, crayon, sayon, tra-	yon	alluvion.	
1	yon, lamprayon, amphictyon, &c.		none.	
11	brise-raison. peson, beson.	aison eson ison	cargaison, &c. garnison, guérison, prison, trahison,	30
	grison, horison, tison, oison, poison,	uson	cloison, foison, moisson, pamoison,	11
	contrepoison. buson, &c.		toison. camuson.	
15	basson, caisson, cavesson, taisson,	sson	paisson, boisson, moisson, cuisson,	6
4	poisson, buisson, frisson, hérisson,		salisson, mousson.	
20	maudisson, nourisson, palisson, polis-	nson çon	chanson. façon, contrefaçon, malfaçon, ran-	1 4
30	son, unisson, saucisson.	don	çon.	1
70	bridon, guéridon, &c.	lon, ron	dondon.	3
15	baron, tendron, &c.	is	laidron, souillon, tatillon.	5
12	abattis, apprentis, iris, tourne-vis,	ois	brebis, souris. chauve-souris, vis,	1
	&c.	dent	iris. fois.	3
700	bois, mois, carquois, harnois, &c.	gent ment	dent, surdent.	1
250	adent, chiendent, curedent, occi-	et uit ot out	gent. jument. forêt.	4
	dent, trident, &c.	ix aux oux	nuit. dot. glout.	9
	acharnement, jugement, &c.		paix, croix, noix, poix. voix, per-	
	ballet, billet, basquet, &c.		drix.	
	minuit, conduit, réduit, &c.		chaux, faux.	
	billot, brulot, complot, &c.		toux.	
	bout, goût, ragoût, &c.			
	faix, choix, crucifix, prix, &c.			
	taux, &c.			
	houx, courroux, époux, &c.			

Number of words of the masculine gender.	Masculine.	Terminations.	Feminine.	Number of words of the feminine gender.
20	art, départ, champart, rempart, &c.	{ art ort	{ hart, part. mort, malemort.	4
	effort, port, fort, tort, &c.	{ er	{ cuiller, mer.	
40	air, éclair, &c.	{ air	{ chair.	5
	tour, contour, four, &c.	{ our	{ cour, tour.	
			aigreur, ampleur, ardeur, blancheur, candeur, chaleur, chandeleur, couleur, clameur, douceur, douleur, épaisseur, erreur, faveur, défaveur, ferveur, fleur, passe-fleur, sans-fleur, fraîcheur, frayeur, froideur, fureur, grandeur, gros-seur, hauteur, horreur, humeur, laid-eur, longueur, largeur, lenteur, li-queur, longueur, lourdeur, maigre-ur, moiteur, noirceur, odeur, pâleur, pes-santeur, peur, primeur, profondeur, puanteur, pudeur, impudeur, rigueur, raideur, rondeur, rougeur, rousseur, rumeur, saveur, senteur, sœur, sou-leur, splendeur, sueur, teneur, terreur, tièdeur, torpeur, touffeur, tumeur, valeur, non-valeur, vapeur, verdeur, vigueur, and mœurs. There are three old words, besides these; basseur, tré-meur, ranceur, which are now obso-lete, and complete the number, 76.	
900	bonheur, malheur, labeur, honneur, déshonneur, cœur, anticœur, crève-cœur, chœur, choufleur, pleur, équa-teur, secteur, &c.	eur		76

As this list of exceptions is pretty accurate, all nouns with the termination *eur* which are not found among the above exceptions, must be considered as being masculine.

A TABLE OF NOUNS WHICH ARE MASCULINE IN ONE SIGNIFICATION AND FEMININE IN ANOTHER.

As if it were not already difficult enough for a foreigner to learn the gender of the nouns of the French language, he must know that certain of them are sometimes masculine, and sometimes feminine, according to their signification, as follows:

Masculine.	Feminine.	Masculine.	Feminine.
Assistant, helper aide	aid, help, support.	A gimblet, piercer	a forêt a wood, a forest.
Eagle, a great ge-nius aigle	a Roman standard.	A large tun	foudre lightning, a thun-der-bolt.
An angel ange	a kind of thorn-back.	Keeper, warden garde	watch, hilt, nurse.
An alder-tree aune	an ell, a sort of measure.	Hoar-frost givre	a serpent, in he-raldry.
Barb, a Barbary horse barbe	beard.	The rolls, the re-gister greffe	a graft.
Bard, a poet barde	a slice of bacon, horse armour.	Gules in heraldry gueule	the mouth of some beasts.
Redbreast berce	cow parsnip.	Guide, director guide	reigns, for govern-ing a horse.
A sort of privateer capre	caper, an acid pickle	Sunflower héliotrope	héliotrope, jasper.
An ornament to painting, a scroll cartouche	cartridge.	Iris, rainbow, iris iris	spring crystal, pro-per name.
A caravan, a hog coche	a notch, a sow.	Lacker, a kind of varnish laque	lacca, gum lac.
Cornet, a stand-cornette ard-bearer	a woman's head-dress, when in dishabille.	A book livre	a pound.
A couple, a male couple and a female	a brace, two of a sort.	A lot of otter's hair loutre	an otter.
A Croatian soldier cravate	a neckcloth.	The handle of a manche tool	a sleeve, English Channel.
Crape crêpe	a pancake.	A labourer manœuvre	the working of a ship.
An echo, the re-tur-n of a sound écho	Echo, a nymph.	Memoir, a bill mémoire	memory.
Ensign, a stand-ard-bearer enseigne	a sign-post.	Thanks merci	pity, mercy.
Example, model, instance exemple	a copy for writing.	Mood, mode mode	fashion.
		A pier or mound môle	mole, moon-calf.

Masculine.		Feminine.
Mould, cast, form moule		mussel, shell-fish.
A ship-boy mousse		moss, a plant.
The philosopher's œuvre		action, an author's
stone		work.
Office, business, office		pantry, larder, but-
prayers		tery.
Ombre, a game at ombre		shade, shadow.
cards		
The page of a		page, in a book.
prince	page	a straw bed.
A merry-andrew paillasse		the branch of a
A hand's breadth palme		palm-tree, vic-
		tory.
Pantomime	pantomime	a dumb show.
Easter, Easter-day pâque		the passover.
A comparison parallèle		a parallel line.
Pendulum pendule		a clock.
Le Perche, a pro-	perche	a Pole, perch, a
vince of France		fish.
Summit, highest		period, epoch.
pitch	période	
Anybody, nobody		a person (a noun).
(pronoun)	personne	a pike.
Spade, at cards pique		
Gnatsnapper, a		peony, a flower.
bird	pivoine	plane, an instru-
A plane-tree	plane	ment.
		a frying-pan.
A stove, a canopy poêle		the post, for let-
Post, a military poste		ters.
station		the laying of eggs.
Punto, at cards ponte		purple fish, purple
Purple colour, pourpre		dye.
purples (a dis-		
ease)		
A pretence prétexte		pretext.
Quadrille, at cards quadrille		party of horse in a
		tournament.
The calling back réclame		a catch-word (in
a hawk		printing).
Rest, relaxation relâche		harbour.
A glass coach remise		a coach-house, a
		remitance.
A sort of pear-tree sans-peau		a sort of pear.
Satyr, a sylvan		
god	satyre	asatire, a lampoon.
Serpentarius	serpenteaire	snake - root, dra-
		gon's-wort.
Nap, slumber	somme	sum, load, name of
		a river.
A smile	souris	a mouse.
A porter	Suisse	Switzerland.
Holder, book-	teneur	tenor, purport, con-
keeper		tent.
A tour, turn, tour		tower, rook at
trick		chess.
Triumph	triomphe	a trump.
Trumpeter	trompette	trumpet
Space	vague	a wave, surge.
A vase, a vessel	vase	the slime in ponds,
		lakes, &c.
A hat of vionia		
wool	vigogne	a vignon, a llama.
A veil	voile	a sail.

TERMINATIONS SHOWING THE SIMILARITY OF WORDS IN FRENCH AND ENGLISH.

There are many words which are alike in both languages. These words are

known by their terminations, as will be seen by the following list :

Terminations.

al	as animal, cardinal, fatal, général, local, moral, &c.
ble	„ capable, fable, &c., Bible, éligible, &c., noble, double, soluble, &c.
ace	„ face, grimace, grâce, place, race, &c.
ance	„ chance, complaisance, extravagance, ignorance, &c.
ence	„ prudence, conférence, continence, patience, &c.
ice	„ artifice, auspice, édifice, orifice, &c.
acle	„ miracle, obstacle, réceptacle, spectacle, &c.
ade	„ ambuscade, brigade, cavalcade, parade, &c.
age	„ âge, adage, cage, image, page, &c.
ege	„ collège, privilège, siège, sortilège, &c.
ge	„ vestige, sage, barge, charge, forge, &c.
ule	„ globule, ridicule, formule, mule, pustule, &c.
ile	„ bile, débile, agile, docile, facile, fragile, &c.
ine	„ carabine, doctrine, héroïne, machine, &c.
ion	„ action, fraction, légion, opinion, passion, &c.
ant	„ arrogant, constant, élégant, éléphant, piquant, &c.
ent	„ absent, accident, compliment, content, élément, &c.

Many other English words require only a change of termination ; as,

gy	into gie	as energy	énergie.
ary	„ aire	„ military	militaire.
ory	„ oire	„ glory	gloire.
cy	„ ce	„ clemency	clémence.
ty	„ té	„ beauty	beauté.
ous, or	„ eux	„ dangerous	dangereux.
eous	„ „	„ courageous	courageux.
our, or	„ eur	„ favour, error	faveur, erreur.
ine	„ in	„ clandestine	clandestin.
ive	„ if	„ attentive	attentif.
ry	„ rie	„ fury	furie.
dy	„ die	„ perfidy	perfidie.

OF THE ARTICLE.

The definition of this word, *Article*, has been the subject of long and spirited discussions among grammarians, who are, even to this day, far from agreeing with each other on the nature of its functions in language.

We wish our pupils to understand, that our object in this grammar is, and will always be, to reach the intelligence of the greatest number, without pretensions to science or novelty. We are satisfied that new denominations, although more rational than those already in use, are of no benefit in practice, and serve only to confuse the minds of pupils.

Without entering into the details of the

numerous systems contained in the most celebrated works on the French language, concerning the nature of this part of speech, we shall adopt the definition of Levisac, as conveying the clearest idea, and being in conformity with the notions generally adopted by scholars and teachers.

"The article, being intended to express the direction of the mind towards the particular object which it has in view, is a word placed before common nouns, to designate that they are about to be taken in a *definite* sense."

Such being the definition of the article, it is evident that there cannot exist what is generally called an *indefinite* article; therefore the words *a, an*, will be hereafter classed among the adjectives.

In English there is but one word to express the article; it is *the*. It is used before nouns of either gender and number; it has neither elision nor contraction.

In French, on the contrary, the article agrees in number and gender with the noun which it precedes; it admits of elision and contraction, as follows:

Without elision.

Before a noun sing. masc. beginning with a consonant, or an *h* aspirated, *the* is expressed by

sing. fem.	"	<i>le.</i>
plur. m. or f.	"	<i>la.</i>
		<i>les.</i>

With elision.

Before a noun sing. masc. or fem., beginning with a vowel, or an *h* mute, *the* is expressed by *l'.*

EXAMPLES.

Without elision.

Sing. Masc.	the day	le jour.
" Fem.	the night	la nuit.

Sing. Masc.	the owl	le hibou.
" Fem.	the hatred	la haine.
Plur. Masc.	the days	les jours.
" Fem.	the nights	les nuits.
" Masc.	the owls	les hiboux.
" Fem.	the hatred (pl.)	les haines.

With elision in the singular.

Sing. Masc.	the bird	l'oiseau.
" Fem.	the soul	l'âme.
" Masc.	the man	l'homme.
" Fem.	the inn	l'hôtellerie.
Plur. Masc.	the birds	les oiseaux.
" Fem.	the soul	les âmes.
" Masc.	the men	les hommes.
" Fem.	the inns	les hôtelleries.

CONTRACTION.

The contraction of the article takes place in the singular masculine, and in the plural masculine and feminine, before all nouns, when it is preceded by either of the prepositions *of* and *to*, *de*, *à*; so that,

of the (1.) before a noun sing. masc., beginning with a consonant or an *h* aspirated, is expressed by *du* (for *de le*).

of the (2.) before a noun sing. fem., beginning with a consonant or an *h* aspirated, is expressed by *de l'.*

of the (3.) before a noun masc. or fem. beginning with a vowel or an *h* mute, is expressed by *de l'.*

of the (4.) before a noun plur. is expressed by *des* (for *de les*).

to the (1.) before a noun sing. masc., beginning with a consonant or an *h* aspirated, is expressed by *au* (for *à le*).

to the (2.) before a noun sing. fem., beginning with a consonant or an *h* aspirated, is expressed by *à la.*

to the (3.) before a noun masc. or fem. beginning with a vowel or an *h* mute, is expressed by *à l'.*

to the (4.) before a noun plur. is expressed by *aux* (for *à les*).

EXAMPLE.

(1.)	of the day	sing. masc.	beginning with	consonant (de le)	du jour.
(2.)	" owl	"	"	<i>h</i> asp. (de le)	du hibou.
	" night	"	fem.	consonant	de la nuit.
	" hatred	"	"	<i>h</i> asp.	de la haine.
(3.)	" bird	"	masc.	a vowel (de le)	de l'oiseau.
	" soul	"	fem.	a vowel (de la)	de l'âme.
	" man	"	masc.	<i>h</i> mute (de le)	de l'homme.
	" inn	"	fem.	<i>h</i> mute (de la)	de l'hôtellerie.
(4)	" days	plur. masc.	"	consonant (de les)	des jours.
	" nights	"	fem.	consonant	des nuits.
	" owls	"	masc.	<i>h</i> asp.	des hiboux.
	" hatred	"	fem.	<i>h</i> asp.	des haines.
	" birds	"	masc.	a vowel	des oiseaux.
	" souls	"	fem.	a vowel	des âmes.
	" men	"	masc.	<i>h</i> mute	des hommes.
	" inns	"	fem.	<i>h</i> mute	des hôtelleries.
(1.)	to the day	sing. masc.	"	consonant (à le)	au jour.
	" owl	"	"	<i>h</i> asp. (à le)	au hibou.
(2.)	" night	"	fem.	consonant (à la)	à la nuit.
	" hatred	"	"	<i>h</i> asp. (à la)	à la haine.

(3.)	to the bird	sing. masc.	beginning with a vowel	(à le) à l'oiseau.
	" soul	" fem.	" a vowel	(à la) à l'âme.
	" man	" masc.	" h mute	(à le) à l'homme.
	" inn	" fem.	" h mute	(à la) à l'hôtellerie.
(4.)	" days	plur. masc.	" consonant	(à les) aux jours.
	" nights	" fem.	" consonant	" aux nuits.
	" owls	" masc.	" h asp.	" aux hiboux.
	" hatred	" fem.	" h asp.	" aux haines.
	" birds	" masc.	" a vowel	" aux oiseaux.
	" souls	" fem.	" a vowel	" aux âmes.
	" men	" masc.	" h mute	" aux hommes.
	" inns	" fem.	" h mute	" aux hôtelleries.

Now that we have explained the mechanism of the article, and have laid it down as a principle that the article is used before a noun taken definitely, agreeing with that noun in number and gender, let us explain what we understand by a noun taken definitely.

A common noun is definite when it signifies a whole species of persons or things, a distinct part of a whole species, or a single individual of a whole species; that is to say, when it is used in reference to the extent of its signification.

A common noun designates a whole species of persons or things, when it represents all the individuals named by that noun; as,

Men are not wicked. *Les hommes ne sont pas méchants.*

Children are troublesome. *Les enfants sont turbulents.*

Man ought to rule his passions. *L'homme devrait régler ses passions.*

In the first and last sentences, *les hommes*, *l'homme*, designate the whole species of beings called men. In the second, *children* signifies the whole species of beings called children. These nouns are therefore used in reference to the whole extent of their signification.

The common noun designates a distinct part of a whole species, when, by some qualification, it separates a certain class from the whole; as,

Wicked men are to be feared. *Les hommes méchants sont à craindre.*

Studious children are loved by their masters. *Les enfants studieux sont aimés de leurs maîtres.*

A weak man is governed by his passions. *L'homme faible est gouverné par ses passions.*

In the first and last sentences we do not speak of all men, but of distinct classes of men; *those who are wicked*, *those who are weak*; and the extent of the signification of the nouns *men* and *children* embraces

all wicked and weak men, and all studious children.

The common noun designates a single individual of a whole species, when it presents to the mind the idea of a single object of that species; as,

The king is loved by his subjects. *Le roi est aimé de ses sujets.*

The man of whom you speak. *L'homme dont vous parlez.*

In these sentences we speak only of *one* king, of *one* man, the *one* of whom you speak; and the extent of the signification of the nouns *king* and *man* is limited to one particular individual of each kind.

The functions of the article, as a part of speech, being to designate the noun which it precedes in a definite manner, it is evident that, where a sentence contains several nouns, used as nominatives or objectives, it must be repeated before each of them; thus we say,

The horses, cattle, sheep, and mules are in the pasture. *Les chevaux, les bestiaux, les brebis, et les mules, sont dans la prairie.*

I have bought the knives, the forks, the glasses, and the decanter, of which we were in need. *J'ai acheté les couteaux, les fourchettes, les verres, et la carafe dont nous avions besoin.*

This rule is not without exceptions, as will be seen when speaking of the repetition of the article.

The article, being definite, cannot be placed before any other word but the common noun, or before words used as such, elliptically or idiomatically; which is sometimes the case with adjectives, verbs, adverbs, and prepositions; as,

The miser is poor among his riches. *L'avare est pauvre au milieu de ses richesses.*

Eating is more necessary than drinking. *Le manger est plus nécessaire que le boire.*

That man would know the how and why of everything. *Cet homme voudrait savoir le pourquoi et le comment de tout.*

There are people who defend the *pro* and *con*, without any motive but love of contradiction. Il y a des personnes qui soutiennent le *pour* et le *contre*, sans autre motif que celui de contredire.

It is evident that in these examples, *l'avare* is used for *the man who is a miser*; *le manger* and *le boire* for *food and drinks*; *pourquoi* and *comment* for *the motive*; *le pour* et le *contre* for *one side of the question and the other*; those words, having changed their nature through an operation of the mind, which has made them common nouns, take the article in accordance with the general rule.

A common noun is indefinite, whenever, instead of being used in reference to the extent of its meaning, it is only employed for the sake of its material signification, representing an object as bearing a name which distinguishes it from other objects of a different kind, but not among those which belong to the same species; thus, when I say, *the road is lined with trees*, the noun *tree* is indefinite, because if it enables me to ascertain, through its material signification, what the road is lined with, it does not show me what particular trees among the large family of trees have been used to line the road; this sentence only signifies that the road is not lined with houses, fences, hedges, &c., but with a certain number of things called trees—but what trees?

If, instead of *trees*, I say, *the road is lined with laurels*, the noun *laurel* is as indefinite as the noun *tree*, because it still only represents to the mind the name of the things with which the road is lined, without reference to any particular laurels having been used for that purpose; the noun *laurel* is therefore used for its material meaning, without any reference to the extent of it.

If, instead of the noun *laurel* alone, I use the following expression, *the road is lined with red laurels*, the noun *laurel* thus qualified is quite as indefinite as the nouns *laurel* and *tree* in the preceding examples; because if it shows that the road is lined not only with *trees*, but with *laurels*, and expresses that these laurels are red, it does not designate, among the family of red laurels, which is the distinct class which has been used to line the road; it is still the mere name of a kind.

If I say now, *the road is lined with red laurels that I gave you*, it would seem at first that the expression has assumed a definite character; but by analysing the sentence we soon discover that it is still as indefinite as the preceding one: for if it shows that the road is lined with trees, that these trees are called laurels, that these laurels are red, and that these red laurels have been given by me, it does not state either that all the laurels which I gave have been used, nor what distinct part of them has been employed; thus the expression, *red laurels that I gave you*, is still but the name of the things the road is lined with and no more, and is therefore indefinite; the preceding sentences should then be expressed without the article, as follows: *La route est bordée d'arbres*: *La route est bordée de lauriers*: *La route est bordée de lauriers roses*: *La route est bordée de lauriers roses que je vous ai donnés*.

A common noun is always indefinite when it is used to qualify a preceding noun, as: I have a *watch of gold*, *J'ai une montre d'or*. In this sentence, the noun *gold* qualifies *watch*, says what it is made of; it shows that my watch is neither made of silver, brass, or any other metal but of that called *gold*, without attaching to this noun any definite idea of individuality, distinction of class or that of a whole; it is therefore indefinite, and does not require the use of the article.

(To be continued.)

HERALD'S COLLEGE.—The heralds of England were first incorporated by Richard III., who gave them a magnificent mansion for their college. The earl-marshal of England is superior for their college, and has the right of appointing the members of which it consists; namely, three kings-at-arms, eight heralds-at-arms, and four pursuivants-at-arms. The kings are Garter Clarencieux, and Norroy. Garter was instituted by Henry V. for the service of the order of the Garter, and is acknowledged as principal king-at-arms. Clarencieux and Norroy are called "provincial kings," the former having jurisdiction over that part of England south of the Trent, and the latter over the country north of that river. The distinguishing colour of garter is blue; of the two provincial kings, purple.



CORAL REEFS.

CORAL REEFS are produced by innumerable small zoophytes, popularly called *Coral-insects*. The Coral insect consists of a little oblong bag of jelly closed at one end, but having the other extremity open, and surrounded by tentacles or feelers, usually six or eight in number, set like the rays of a star. Multitudes of these minute animals unite to form a common stony skeleton called *Coral*, or *Madrepore*, in the minute openings of which they live, protruding their mouths and tentacles when under water; but suddenly drawing them into their holes when danger approaches. These animals cannot exist at a greater depth in the sea than about ten fathoms, and as the Coral Islands often

rise with great steepness from a sea more than three hundred fathoms deep, it would seem that a great alteration must have taken place in the depth of the ocean since the time when the little architects commenced their labours. Throughout the whole range of the Polynesian and Australasian islands, there is scarcely a league of sea unoccupied by a coral reef, or a coral island; the former springing up to the surface of the water, perpendicularly from the fathomless bottom, "deeper than did ever plummet sound," and the latter in various stages, from the low and naked rock, with the water rippling over it, to an uninterrupted forest of tall trees. "I have seen," says Dalrymple, in his '*Inquiry into the formation of Islands*,' "the coral banks in all their stages; some in

deep water; others with a few rocks appearing above the surface; some just formed into islands, without the least appearance of vegetation; others with a few weeds on the highest part; and lastly, such as are covered with large timber, with a bottomless sea, at pistol-shot distance." In fact, as soon as the edge of the reef is high enough to lay hold of the floating sea-wreck, or for a bird to perch upon, the island may be said to commence. The dung of birds, feathers, wreck of all kinds, cocoa-nuts floating with the young plant out of the shell, are the first rudiments of the new island. With islands thus formed, and others in the several stages of their progressive creation, Torres' Strait is nearly choked up; and Captain Flinders mentions one island in it covered with the *Casuarina*, and a variety of other trees and shrubs, which give food to paroquets, pigeons, and other birds, to whose ancestors, it is probable, the island was originally indebted for this vegetation. The time will come—it may be ten thousand, or ten millions of years, but come it must—when New Holland, and New Guinea, and all the little groups of islets and reefs, to the north and north-west of them, will either be united in one great continent, or be separated only with deep channels, in which the strength and velocity of the tide may obstruct the silent and unobserved agency of these insignificant, but most efficacious labourers.

A barrier reef of coral runs along the whole of the eastern coast of New Holland; "among which," says Captain Flinders, "we sought fourteen days, and sailed more than five hundred miles, before a passage could be found through them out to sea." Captain Flinders paid some attention to the structure of these reefs, on one of which he suffered shipwreck. Having landed on one of these new creations, he says, "We had wheat-sheaves, mushrooms, stags' horns, cabbage-leaves, and a variety of other forms, growing under water, with vivid tints of every shade betwixt green, purple, brown, and white."—"It seems to me," he adds, "that when the animalcules, which form the coral at the bottom of the ocean, cease to live, their structures adhere to each other, by virtue either of the glutinous remains within, or of some property in salt water;

and the interstices being gradually filled up with sand and broken pieces of coral washed by the sea, which also adhere, a mass of rock is at length formed. Future races of these animalcules erect their habitations upon the rising bank, and die in their turn, to increase, but principally to elevate, this monument of their wonderful labours." He says, that they not only work perpendicularly, but that this barrier wall is the highest part, and generally exposed to the open sea, and that the infant colonies find shelter within it. A bank is thus gradually formed, which is not long in being visited by sea-birds; salt-plants take root upon it, and a soil begins to be formed; a cocoa-nut, or the drupe of a pandanus, is thrown on shore; land-birds visit it, and deposit the seeds of shrubs and trees; every high tide and gale of wind add something to the bank; the form of an island is gradually assumed; and, last of all, comes man to take possession.

"Every one," says Mr. Darwin, "must be struck with astonishment when he first beholds one of these vast rings of coral rock, often many leagues in diameter, here and there surmounted by a low verdant island with dazzling white shores, bathed on the outside by the foaming breakers of the ocean, and on the inside surrounding a calm expanse of water, which, from reflection, is of a bright but pale green colour. The naturalist will feel this astonishment more deeply after having examined the soft and almost gelatinous bodies of these apparently insignificant creatures; and when he knows that the solid reef increases only on the outer edge, which, day and night, is lashed by the breakers of an ocean never at rest."

Coral being beautiful in form and colour, is sought after for purposes of ornament; and its fishery or gathering gives employment to many persons in the Red Sea, the Persian Gulf, the Mediterranean, and other places. In the Straits of Messina, the rocks which yield coral are from about 350 to 650 feet below the surface of the water. The coral here grows to about the height or length of twelve inches, and requires eight or ten years to come to perfection. In the general mode of fishing for coral, the instrument used

consists of two heavy beams of wood, secured together at right angles, and loaded with stones to sink them. Hemp and netting are attached to the under side of the beams, to the middle of which is secured one end of a strong rope, by which the apparatus is let down from a boat, and guided to the spots where the coral is most abundant. The branching form of the coral causes it to become entangled in the hemp and network, by which means it is broken off from the rock, and drawn up with the apparatus to the surface of the water.

DOMESTIC LIFE AND MANNERS OF THE ANCIENT EGYPTIANS.

THE Pyramids, temples, and palaces of Egypt have been secured by their massive strength against entire destruction; but the houses were built of perishable materials, and no such fortunate accident as that which preserved Pompeii has enabled us to look into the interior of an ancient Egyptian town. We search in vain even for foundations in many places, where the former existence of a considerable population is clearly proved by extensive cemeteries. The houses were built, in general, of crude brick, and they have either fallen to decay, or been destroyed, that their materials might be applied to other purposes. At Thebes, the blackened remains of the foundations bear traces of the conflagrations to which, from the time of Cambyses downward, the city was exposed. But from these, though we may discover the strength of the walls, and the size of the lowest apartments, we could gain no information respecting the interior disposition of the inhabited part, or the height to which the house was raised, and little respecting the arrangement of the streets. Fortunately the paintings of the sepulchres, which so generally relate to domestic life, have preserved some views of the houses in which the scenes represented were carried on. Sir Gardiner Wilkinson has explored the remains of an ancient town near Tel-Amarna, which he believes to be Alabastron; and though they may not belong to very remote times, they serve to enlarge the scanty information which we derive from other sources.

Diodorus, speaking of the second Busiris;

whom he represents as the founder of Thebes, says, that he built the houses of private persons some with four, some with five stories. In the historian's age, great part of Thebes had been long in ruins, and certainly no houses existed there to prove what had been the style of architecture in the mythic reign of Busiris. His statement is probably one of those exaggerations, by which the glory of this ancient capital was magnified. That the houses should have been of that height would be inconsistent with what Diodorus himself tells us of the indifference of the Egyptians to the magnitude and splendour of their dwellings; it is contrary to the practice of the East in all ages, and to the evidence of the paintings. From these we may conclude that the ordinary plan of an Egyptian house comprehended only a single story besides the basement, with a terrace on the roof, open or covered, surrounded by a balustrade, or battlement. In hot climates, two great objects in the arrangement of houses are to admit air and exclude heat. To attain the latter, the Egyptians made their windows small, and their apartments lofty; and for ventilation it is probable that they had a contrivance in the roof, similar to that which is now used in Egypt. Houses which stood detached and enclosed within a wall of their own, had an ornamented garden around them, such as we have already described. Their villas were still more spacious, comprehending a variety of apartments, and had frequently the appendage of a farm-yard. The walls of the principal rooms were covered with stucco, and ornamented with paintings. These have generally perished; but from the tombs it is evident that the Egyptians in very early times had made great advances in house decoration. Their walls and ceilings are painted in a variety of patterns, combining elegance of form with richness of colouring. Many of them, even of very early kings, exhibit a remarkable resemblance to those which we see in the Mosaics of the Romans, and which have been imitated in our carpets and floor-cloths. What is called the Mæander, or Greek border, appears in a tomb of the eighteenth dynasty. The resemblances are so numerous and so striking, as to leave no doubt that the Greeks and

Romans derived from Egypt these combinations, the artistic excellence of which is attested by the circumstance that they please as much at the present day, as in the remote age when they made their first appearance.

The tombs contain a considerable number of specimens of Egyptian furniture, but they are usually of an uncostly kind; the luxury which prevailed is, however, sufficiently attested by the paintings. Compared with modern houses, those of Egypt, indeed, would seem scantily furnished; they had neither curtains, nor carpets, nor mirrors, nor the elegant apparatus of bookshelves, chiffoniers and writing-desks, which literary habits have introduced among us. Musical instruments, too, were not with them part of the furniture. Stands for flowers, vases of perfume, and even altars for the reception of offerings which were not to be consumed by fire, appear frequently in representations of the interior scenes of Egyptian life. Besides these, tables, chairs, and couches were the principal articles which their rooms contained, and these in wealthy houses were made of costly materials; elaborately wrought and polished. Their forms display freedom and elegance; some of them, as the imitation of the legs and feet of animals, have been perpetuated to the present day in the workmanship of the corresponding pieces of furniture. The thrones or chairs of state, which are pictured in the tombs of the kings, were richly gilt and painted, and luxuriously cushioned; the back bends with an easy and graceful curve; the head of a lion, or the entire figure, forms the arm; the sides are occupied with emblematical devices, or the representation of captives bound beneath the throne of the sovereign. The footstools and seats are also richly carved and covered, and exhibit the enemies of Egypt in the same humiliating posture. When the Egyptians reclined on couches which had no back or scroll at the end for the support of the head, its place was supplied by a semicircle of polished wood upon a stand, on which the head was rested. In that climate the contact of the head during the day with a soft pillow would have been intolerable, and this substitute continues to be used among the Nubian tribes. Whatever may be said of the stiffness

and uniformity of Egyptian style when employed on sacred subjects, the artists displayed a sense of beauty and grace, where they were not fettered by religious or conventional restrictions, which places them above all ancient nations except the Greeks.

The Egyptians, like the Greeks in Homer's time, and the Israelites, till a late period of the monarchy, sat at meat instead of reclining. The Greeks sat in chairs, but the Egyptians on the ground, with the legs bent beneath them, or on a very low stool, sometimes only a mat or a carpet. The dishes, therefore, would be placed on a table slightly raised above the floor, as now practised in the East, or served round to each guest. Neither knives nor forks were in use, but spoons for eating and ladles for helping have been found. At entertainments, the guests, who were of both sexes, were anointed by the attendants before the feast began, and flowers were placed on their heads, around their necks, and in their hands. From the history of Joseph we learn that at Pharaoh's court it was the business of a chief of the culinary department to prepare pastry for the monarch's table; and the monuments prove that it was made with great care, and fashioned into a variety of elegant forms. Except in this respect, the Egyptian cookery appears to have been simple—fish, beef, and goose being the chief articles of food. Gazelles and kids are also seen in the hands of the cooks, preparing for the table. The wine and water were placed in porous jars, and the process of evaporation by which they were cooled was promoted by their being fanned. The water of the Nile was purified probably by mixing paste of almonds with it, according to the present practice. Music accompanied the feast; and the Egyptians, like the Greeks, appear to have amused themselves with gymnastic performers and jugglers, and the antics of dwarfs and deformed persons. With what religious rites their more solemn feasts were inaugurated we do not know; in the Ptolemaic times royal banquets appear to have been introduced by prayers for the welfare of the king and the prosperity of the kingdom. At the close of feasts among the wealthier classes, according to Herodotus, a figure of a mummy elabo-

rately painted and gilded, a cubit in length, was carried round by an attendant, who thus addressed the guests: "Looking on this, drink and enjoy thyself; for such shalt thou be when thou art dead." This sounds like an Epicurean exhortation to the enjoyment of life; the same exhibition, however, was susceptible of a moral turn, such as Plutarch gives it. "The skeleton," says he, "which the Egyptians appropriately introduce at their banquets, exhorting the guests to remember that they shall soon be like him, though he comes as an unwelcome and unseasonable boon-companion, is nevertheless, in a certain sense, seasonable, if he exhorts them not to drink and indulge in pleasure, but to cultivate mutual friendship and affection and not to render life, which is short in duration, long by evil deeds." This by no means implies that the Egyptians applied it to such a purpose, and he elsewhere speaks of the custom, like Herodotus, as designed to exhort the guests to the enjoyment of life.

An Egyptian custom, which appeared to Herodotus very remarkable, was that of singing a song in honour of Maneros. As he introduces the mention of it immediately after the carrying round of the image, and as Plutarch expressly says that it was used at their banquets, it is probable that it was one of their festive customs. Who Maneros was is variously explained. According to Herodotus, he was the only son of the first king of Egypt (by whom, perhaps, Osiris, not Menes, was originally intended,) and had died an untimely death. As the same strain, under the name of Linus, was sung by the Greeks, and under some other name by the Phœnicians in their own country and in Cyprus, it is evident that the custom of singing it cannot have originated in the death of the only son of Menes. A mythic origin, from some circumstance which was equally interesting to the feelings of all those nations, is much more probable. Plutarch says Maneros was the son of the king of Byblos, involuntarily killed by Isis; and Linus was reputed to have been either the son of Apollo, killed by Hercules, or of Urania killed by Apollo. Sappho conjoined Adonis and Linus in one lamentation, whence it is probable that both were personages of the same mythic cha-

racter. The mourning rites which made a part of all the ancient religions, have a primary reference to autumn and winter, when the sun appears to decline in vigour, and be preparing for extinction, and vegetative power to be buried in the earth. As the song of Maneros was the most ancient and universal among the Egyptians, it was natural that its origin should be referred to the history of their first king. As the Maneros was a mournful strain, its use at banquets harmonized well with the exhibition of the skeleton or mummy—one reminding the guests of the transitory life of man, and the other of the short-lived beauty of the external world.

It has been generally thought that common life had a very grave and melancholy aspect among the Egyptians, who were oppressed and impoverished by the predominance of the priesthood. The insight which we have gained into their interior life, by means of the monuments, has shown that this was by no means the case. It is true that they had no theatre, like the Greeks, no circus, like the Romans; and that their public religious ceremonies were not diversified by exhibitions of strength and skill, of musical taste and literary ability, like the great panegyrics of Greece. But the life of the people was not so monotonous as it has been supposed to be. We find in the grottoes of Beni-hassan, not only representations of bodily contests, which were probably a part of the military training, but games carried on both by men and women, which are evidently the amusement of the people. In these paintings we see women, generally distinguished by a cap, from the back part of which two or three strings of twisted ribbon depend, playing with balls, sometimes as many as six at once, and engaged in trials of strength, which exhibit flexibility of the limbs in the most extraordinary degree. They make an arch of their inverted bodies, touching the ground with the feet and the back of the head, or stand on the head with the heels in the air. One couple are performing an evolution which is still common with children, locking their arms together behind, and lifting each other, or rising from the ground, by bringing the hands and feet to meet. In these feats the women are

dressed in tight pantaloons. Among other exercises and contests two men are seen playing at single-stick, their left arms being guarded by shields of wood fastened with straps similar to those which are worn in Italy at the present day, by the players at *pallone*. Another game is exhibited, which is still in use; a man is stretched with his face on the ground, and two others, kneeling over him, strike him with their fists; he is required to guess which strikes him, and if he names the right person, the striker takes his place upon the ground. Others appear to be trying which can fling a pointed knife, so as to enter the most deeply into a block of wood, or raise a bag of sand and sustain it the longest with the uplifted arm. We know that in later times it was a common recreation of the Egyptians to go in boats upon the branches of the Nile in the Delta, or the lakes which it forms as it approaches the sea, and spend the day in festivity under the shade of the Egyptian bean, which grew to the height of many feet. Another amusement which they practised on the river was to man boats, and rowing them rapidly, to hurl or thrust javelins without points against each other as they passed. Such a scene is represented in one of the oldest monuments of Egypt, the tomb of Imai at Gizeh; and one of the parties has been thrown into the river by the shock. In another tomb at Kum-el-Ahmar, we see tables with refreshments spread upon them for the use of the parties engaged in the mimic contest. The young men of London in former times amused themselves with similar encounters on the Thames.

Dice have been found at Thebes, marked in the modern manner, but their age is uncertain. Their use must have been common in the time of Herodotus, since the priests represented Rhampsinitus as playing at dice with Ceres; and we may presume that they would not have given their myth this form, had they known that the game was of very recent introduction. We do not, however, find any representation of it among the monuments. The account which Plutarch gives of Mercury playing at dice with the moon, and winning from her the five odd days of the year, is evidently a fiction of later times.

and therefore furnishes no evidence of an ancient usage. But it appears from the monuments that a game answering to our draughts was in use in very remote ages. Plato attributes the invention both of dice and playing-tables to the Egyptians. In one of the grottoes of Benihasan two men appear seated on the ground with a low table before them, on which are arranged six green and six yellow pieces, all of the same form, with which they are evidently playing; in one instance the greens and yellows are arranged in lines before the respective players, in the other they are intermixed alternately through the whole length of the board. How the board was divided is not shown either here or in the palace of Rameses IV., at Medinet Abou, where the king appears seated, and playing at this game with a female, probably a royal concubine, who stands before him. The game of *mora*, played by the ancient Romans, and with such passionate eagerness by the modern Italians, was practised in Egypt. The tricks of the juggler also afforded them amusement; we see two men seated, with four inverted cups placed between them, and it is evident that the game consisted in guessing beneath which of the cups some object was concealed.

The vast difference between ancient and modern times, produced by language, religion, the art of war, the improvements in mechanics, cause them at first sight to seem separated by a gulf, in which all transmissions of manners and customs is lost. This is especially the case in regard to ancient Egypt, whose peculiarities made it, even to the Greeks and Romans, a world apart from their own. The middle ages produced a similar apparent disruption between the Greek and Roman world and ours. The discovery of so much in Egyptian life, as revealed by the monuments, which closely resembles our own, restores the continuity of ages, and shows that the great revolutions which change the opinions and institutions of mankind and transfer power and civilization to distant regions, leave untouched and unchanged a great mass of the human race, among whom the customs of daily life are perpetuated, and by whose mediation the most distant times and countries are united.

NATURAL PHILOSOPHY.

CHAPTER VIII.—(continued).

Even when gases are separated from each other by barriers, which, strictly speaking, are not porous, the same phenomenon takes place. Thus, if with the finger, we spread a film of soap-water over the mouth of a bottle, *a*, and then expose it under a jar to some other gas, such as carbonic acid, this gas percolates rapidly through the film, and, accumulating in the bottle, distends the film into a bubble, as represented in Fig. 46. Meanwhile, a little atmospheric air escapes out of the bottle through the film in the opposite direction.



Fig. 46.

This propensity of gases to diffuse into each other is clearly shown by filling a bottle, *H*, Fig. 47, with a very light gas, as hydrogen; and a second one *C*, with a heavy gas, as carbonic acid, and putting the bottles mouth to mouth. Diffusion takes place, the light gas descending and the heavy one rising until both are equally commixed. We see, therefore, that this property of gases is intimately concerned in determining the constitution of the atmosphere, which is made up of different substances, some of which are light and some heavy—the heavy ones not sinking, nor the light ones ascending, but both kept equally commixed by diffusion into each other.

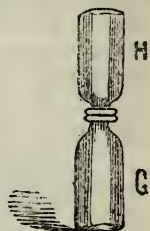


Fig. 47.

SECTION II.—HYDROSTATICS AND HYDRAULICS.

CHAPTER IX.

PROPERTIES OF LIQUIDS.

Extent and Depth of the Sea.—Its Influence on the Land.—Production of Fresh Waters.—Relation of Liquids and Gases.—Physical Condition of Liquids.—Different Degrees of Liquidity.—Florentine Experiment on the Compression of Water.—Oersted's Experiments.—Compressibility of other Liquids.

HAVING disposed of the mechanical properties of atmospheric air, which is the type of gaseous bodies, in the next place we pass to the properties of water, which is the representative of the class of Liquids.

About two-thirds of the surface of the earth are covered with a sheet of water, constituting the sea, the average depth of which is commonly estimated at about two miles. This, referred to our usual standards of comparison, impresses us at once with an idea of the great amount of water investing the globe; and, accordingly, imaginative writers continually refer to the ocean as an emblem of immensity.

But, referred to its own proper standard of comparison—the mass of the earth—it is presented to us under a very different aspect. The distance from the surface to the centre of the earth is nearly four thousand miles. The depth of the ocean does not, therefore, exceed $\frac{1}{2000}$ th part of this extent: and astronomers have justly stated, that were we on an ordinary artificial globe to place a representation of the ocean, it would scarcely exceed in thickness the film of varnish already placed there by the manufacturer.

In this respect the sea constitutes a mere aqueous film on the face of the globe. Yet, insignificant as it is in reality, it has been one of the chief causes engaged in shaping the external surface, and also of modelling the interior to a certain depth—for geological investigations have proved the former action of the ocean on regions now far removed from its influence, in the interior of continents; and also its mechanical agency in the formation of the sedimentary or stratified rocks which are of enormous superficial extents and often situated at great depths.

Besides the salt waters of the sea, there are collections of fresh waters, irregularly disposed, constituting the different lakes, rivers, &c. The direct sources of these are springs, which break forth from the ground, the little streams from which coalesce into larger ones. But the true source of all our terrestrial waters is the sea itself. By the shining of the sun upon it a portion is evaporated into the air, and this, carried away by winds and condensed again by cold, descends from the atmosphere as showers of rain, which, being received upon the ground, percolates until it is stopped by some less pervious stratum, and flowing along this at last breaks out wherever there is opportunity in the low grounds—thus constituting a spring. Such streamlets coalesce into rivers, which find their way back again to the sea, the point from which they originally came—an eternal round, which is repeated for centuries in succession.

From these more obvious phenomena of Nature we discover a relationship between aerial and liquid bodies—the one passing without difficulty into the other form—and, indeed, many of the most important events around us depending on that fact. Experiment also shows that, in many instances, substances which under all common circumstances exist in the gaseous condition, can be made to assume the liquid. Thus, carbonic acid, which is one of the constituents of the atmosphere, can by pressure be reduced to the liquid form, and can even be made to assume that of a solid. The main agents by which such transmutations are affected are cold and pressure.

The parts of liquids seem to have little cohesion. Viewing the forms of matter as being determined by the relation of those attractive and repulsive forces which are known to exist among particles, it is believed in that now under consideration—the liquid—that these forces are in equilibrio. For this reason, therefore, the particles of such bodies move freely among one another; and liquids, of themselves, cannot assume any determinate shape, but conform their figure to the vessels in which they are placed. Portions of the same liquid added to one another readily unite.

Among liquids we meet with what may be termed different degrees of liquidity. Thus the liquidity of molasses, oil, and water, is of different degrees. It seems as though there was a gradual passage from the solid to this state, a passage often exhibited by some of the most limpid substances. Thus alcohol, when submitted to an extreme degree of cold, assumes that partial consistency which is seen in melting beeswax, yet at common temperatures it is one of the most mobile bodies known. So, too, that compound of tin and lead which is used by plumbers as a solder, though perfectly fluid at a certain heat, passes, in the act of cooling, through various successive stages, and at a particular point becomes plastic and may be moulded with a cloth.

If a quantity of atmospheric air is pressed upon by any suitable contrivance, it shrinks at once in volume. We have already proved this phenomenon and determined its laws. If water is submitted to the same trial, the result is very different—it refuses to yield: for this reason, inasmuch as the same fact applies to the whole class, liquids are spoken of as incompressible bodies.

It was at one time thought that the experiment of the Florentine academicians, who filled a gold globe with water; and on compressing it with a screw found the water ooze through the pores of the gold, proved completely the incompressibility of that liquid.* But more recent experiments have shown, beyond all doubt, that liquids are

* The experiment alluded to by Professor Draper was performed at the Academy *Del Cimento*, in Florence, more than two centuries ago, and is now generally adduced to prove the porosity of gold in common with all other bodies.—W. T. K.

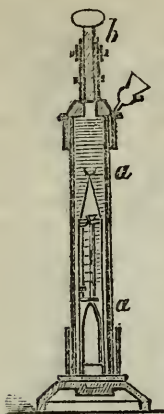


Fig. 48.

compressible, though in a less degree than gases. Thus, it is a common experiment to lower a glass bottle, filled with water and carefully stopped with a cork, into the sea. On raising it again the cork is often found forced in, and the water is uniformly brackish. But in a more exact manner the fact can be proved, and even the amount of compressibility measured, by Ørsted's machine. This consists of a strong glass cylinder, *a a*, Fig. 48, filled with water, upon which pressure can be exerted by a piston driven by a screw, *b*. When the screw is turned and pressure on the liquid exerted, it contracts into less dimensions, but at the same time the glass, *a a*, yielding, distends, and the contraction of the water becomes complicated with the expansion of the glass in which it is placed.

To enable us to get rid of this difficulty, the instrument, Fig. 48, is immersed in the cylinder of water, as

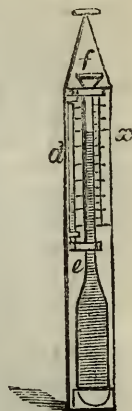


Fig. 49.

seen at Fig. 49. This consists of a glass reservoir, *e*, prolonged into a fine tube, *e f*, with a scale, *x*, attached to it. The reservoir and part of the tube are filled with water, and a little column of quicksilver, *x*, is upon the top of the water, serving to show its position. On one side there is a gauge, *d*, partially filled with air. It serves to measure the pressure.

Now when the instrument, Fig. 48, is put in the cylinder in the position indicated in Fig. 49, and pressure made by the screw, *b*, it is clear that the water in the reservoir will be compressed, and the glass which contains it being pressed upon equally, internally and externally, will yield but very little. Making allowance, therefore, for the small amount of compression which the glass thus equally pressed upon undergoes, we may determine the compressibility of the water as the force upon it varies. It thus appears that water diminishes $\frac{1}{22000}$ part of its volume for each atmosphere of pressure upon it. In the same way the compressibility of alcohol has been determined to be $\frac{1}{11000}$.

CHAPTER X.

THE PRESSURE OF LIQUIDS.

Divisions of Hydrodynamics.—Liquids seek their own Level.—Equality of pressure.—Case of different Liquids pressing against each other.—General Law of Hydrostatics.—Hydrostatic Paradox.—Law for Lateral Pressures.—Instantaneous communication of Pressure.—Bramah's Hydraulic Press.

To the science which describes the mechanical properties of liquids the title of **HYDRODYNAMICS*** is applied. It is divided into two branches, **Hydrostatics**† and **Hydraulics**‡. The former considers the weight and pressure of liquids, the latter their motions in canals, pipes, &c.

* From the Greek *udor* (ὕδωρ) water, and *dunamis* (δύναμις) power. [Hydrodynamics is the science which applies the principles of Dynamics, to determine the conditions of motion and rest in fluid bodies, and is divided into four parts, according as fluids are incompressible or elastic, and according as their equilibrium or their motion is considered.]—*Playfair's "Natural Philosophy."* 3rd Edition, Vol. 1, p. 163.

† From the Greek *udor* (ὕδωρ) water, and *stasis* (στάσις) standing. [By hydrostatics is commonly understood that part of natural philosophy which considers the equilibrium and pressure of fluids in general, though that word seems to be restrained to water, which is a particular fluid, and the most obvious of all fluids; and by means of which we shall make out most of our following conclusions.]—*Cotes's Hydrostatical and Pneumatical Lectures.*

‡ From the Greek *udor* (ὕδωρ) water, and *aulos* (αὐλός) a pipe or tube. [Hydraulics is that branch of natural philosophy which treats of the motions of liquids, the laws by which they are regulated, and the effects they produce.]—*Brand's "Dictionary of Science, Literature, and Art,"* 1st Edition, p. 570.

A liquid mass exposed without any confinement to the action of gravity would spread itself into one continuous superficies, for all its parts gravitate independently of one another, each part pressing equally on all those around it, and being pressed on equally by them.

A liquid confined in a receptacle or vessel of any kind conforms itself to the solid walls by which it is surrounded, and its upper surface is perfectly plane, no part being higher than another. This level of surface takes place even when different vessels communicating with each other are used. Thus, if into a glass of water we dip a tube, the upper orifice of which is temporarily closed by the finger, but little water will enter, owing to the impenetrability of the air; but, as soon as the finger is removed, the liquid instantly rises, and finally settles at the same level inside of the tube that it occupies in the glass on the outside.

This result obviously depends on the equality of pressure just referred to, and it is perfectly independent of the form or nature of the vessel. If we take a tube bent in the form of the letter U, and closing one of its branches with the finger, pour water into the other, as soon as the finger is removed the liquid rises in the empty branch, and, after a few oscillatory movements, stands at the same level in both.

If one of the branches of such a tube is much wider than the other, the same result

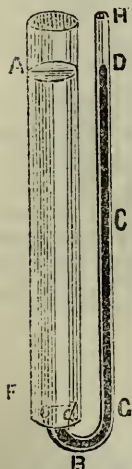


Fig. 50.

still ensues. Thus, as in Fig. 50, we might have a reservoir, A F, exposing an area of ten, or a hundred, or ten thousand times that of a tube rising from it, B G C H; but in the latter a liquid would rise no higher than in the former, both being at precisely the same level, A D. We perceive, therefore, from such an experiment, that the pressure of liquids does not depend on their absolute weight, but on their vertical altitude. The great mass of liquids contained in A exerts no more pressure on C than would a smaller mass contained in a tube of the same dimensions as C itself.

A variation of this experiment will throw much light upon the subject. Instead of using one, let there be two liquids, of which the specific gravities are different. Put one in one of the branches of the tube, *a b c*, Fig. 51, and the other in the other. Let the liquids be quicksilver and water. It will be found, under these circumstances, that the water does not press the quicksilver up to its own level, but that, for every thirteen

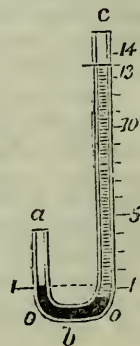


Fig. 51.

and a half inches vertical height that it has in one of the branches the quicksilver has one inch in the other. Of course, as they communicate through the horizontal branch, *b*, the quicksilver must press against the water as strongly as the water presses against it; if it did not, movement would ensue. And such experiments, therefore, prove that it is the principle of equality of pressures which determines liquids to seek their own level.

From this it therefore appears that a liquid in a vessel not only exerts a pressure upon the bottom in the direction in which gravity acts, but also laterally and upward.

From what was proved by the experiment represented in Fig. 50, it follows that these pressures are by no means necessarily as the mass, but in proportion to the vertical height. If one hundred drops of water be arranged in a vertical line, the lowest one will exert on the surface on which it rests a pressure equal to the weight of the whole. And from such considerations we deduce the general rule for estimating the pressure a liquid exerts upon the base of a vessel. "Multiply the height of the fluid by the area of the base on which it rests, and the product gives a mass which presses with the same weight."

Thus, in a conical vessel, E C D F, Fig. 52, the base, C D, sustains a pressure measured by the column A B C D. For all the rest of the liquid only presses on A B C D laterally, and resting on the sides E C and F D, cannot contribute anything to the pressure on the base, C D. But in a conical vessel, E C D F,

Fig 53, the pressure on A B is measured by A B C D, as before; but the other portions of the liquid, not resting upon the sides, press also upon the bottom, E F,—and the result, therefore, is the same as if the vessel were filled throughout to the height C D.

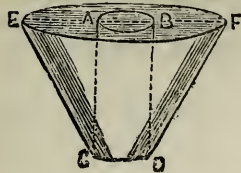


Fig. 52

This law is nothing more than an expression of the fact that the actual pressure of a liquid is dependent on its vertical height and the area of its base. Its applications

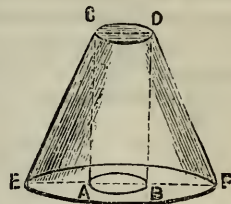


Fig. 53.

give rise to some singular results. Thus, the hydrostatic bellows consists of a pair of boards, A, Fig. 54, united together by leather, and from the lower one there rises a tube *e* B *e*, ending in a funnel-shaped termination, *e*. If heavy weights are put upon the upper board, or a man stands upon it, by pouring water down the tube the weight can be raised. It is immaterial how slender the tube, and, therefore, how small the quantity of water it contains, the total pressure resulting depends on the area of the bellows-boards, multiplied by the vertical height of the tube.

Theoretically, therefore, it appears that a quantity of water, however small, can be made to lift a weight however great—a principle sometimes spoken of as the HYDROSTATIC PARADOX.

But liquids exert a pressure against the sides, as well as upon the bases of the containing vessel—the force of that pressure depending on the height. The law for estimating such pressure is, “the horizontal force exerted against all the sides of a vessel is found by multiplying the sum of the areas of all the sides into a height equal to half that at which the liquid stands.”

When bodies are sunk in a liquid, the liquid exerts a pressure which depends conjointly on the surface of the solid and the depth to which its centre is sunk. Thus, if into a deep vessel of water we plunge a bladder, to the neck of which a tube is tied, the bladder and part of the

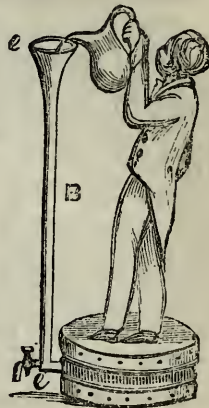


Fig. 54.

tube being filled with coloured water, it will be seen, as the bladder is sunk, that the coloured water rises in the tube.

A pressure exerted against one portion of a liquid is instantly communicated throughout the whole mass, each particle transmitting the same pressure to those around. A striking illustration of this is seen when a Prince Rupert's drop is broken in a glass of water, the glass being instantly burst to pieces.

Bramah's press, or the hydrostatic press, is an illustration of the principle developed in this lecture—that every particle of a fluid transmits the pressure it receives, in all directions, to those around. It consists of a small metallic forcing-pump, *a*, Fig. 55, in which

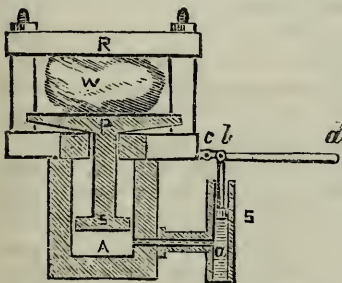


Fig. 55.

a piston *s*, is worked by a lever, *c b d*. This little pump communicates with a strong cylindrical reservoir, A, in which a water-tight piston, S, moves, having a stout flat head, P, between which and a similar plate, R, supported in a frame, the substance to be compressed, W, is placed. The cylinder A, and the forcing-pump, with the tube communicating between them, are filled with water, the quantity of which can be increased by working the lever, *d*. Now it is obvious that any force, impressed upon the surface of the water in the small tube, *a*, will, upon the principles just described, be transmitted to that in A, and the piston, S, will be pushed up with a force which is proportional to its area, compared with that of the piston of the little cylinder, *a*. If its area is one thousand times that of the little one, it will rise with a force one thousand

times as great as that with which the little one descends—the motive force applied at *d*, moreover, has the advantage of the leverage, in proportion as *c d* is greater than *c b*. On these principles it may be shown that a man can, without difficulty, exert a compressing force of a million of pounds by the aid of such a machine of comparatively small dimensions.

CHAPTER XI.

SPECIFIC GRAVITY.

Definition of the term.—The Standards of Comparison.—Method for Solids.—Case when the Body is Lighter than Water.—Method for Liquids by the Thousand-Grain Bottle.—Effects of Temperature.—Standards of Temperature.—Other Methods for Liquids.—Method for Gases.—Effects of Temperature and Pressure.—The Hydrometer or Aræometer.

By the specific gravity of bodies we mean the proportion subsisting between absolute weights of the same volume. Thus, if we take the same volume of water and copper, one cubic inch of each, for example, we shall find that the copper weighs 8·6 times as much as the water: and the same holds good for any other quantity, as ten cubic inches or one cubic foot. When of the same volume the copper is always 8·6 times the weight of the water.

Specific gravity is, therefore, a relative affair. We must have some substance with which others may be compared. The standard which has been selected for solids and liquids is water; that for gases and vapours, atmospheric air.

When we speak of the specific gravity of a substance which is of the liquid or solid kind, we mean to express its weight compared with the weight of an equal volume of water. Thus, the specific gravity of mercury is 13·5; this is to say, a given volume of it would weigh 13·5 times as much as an equal volume of water.*

A TABLE OF THE MEAN SPECIFIC GRAVITIES OF VARIOUS BODIES, AT A TEMPERATURE OF 60° FAHRENHEIT.

1. SOLIDS.					
Platina, laminated.....	22·069	Fluor Spar	3·181	Walnut-tree (dry)	0·650
— purified	19·500	Marble, Parian white ..	2·837	Cedar	0·613
Gold, cast.....	19·258	— Carrara white.....	2·716	Willow	0·585
— hammered	19·361	Rock Crystal	2·653	Fir	0·580
— standard, 22 carats	17·486	Flint	2·594	Poplar	0·383
Mercury, solid.....	13·610	Selenite (Sulphate of		Cork	0·270
Lead, cast.....	11·352	Lime).....	2·322		
Silver, hammered	10·510	Common Salt	2·130	2. FLUIDS.	
— cast	10·474	Sulphur, native	2·033	Mercury, fluid.....	13·568
Sulphuret of Mercury ..	10·000	Plumbago, or Black Lead	1·860	Oil of Vitriol (Sulphuric	
Bismuth, cast.....	9·822	Ivory	1·820	Acid).....	1·840
Copper, cast.....	9·788	Phosphorus	1·770	Nitric Acid (highly con-	
Brass, wire	8·544	Lignum Vitæ	1·327	centrated).....	1·582
— cast	8·395	Coal	1·270	— (Aqua Fortis)	1·271
Steel, soft	7·833	Jet	1·238	Honey	1·450
— tempered.....	7·816	Coral	1·210	Hydrochloric Acid (Spirit	
Nickel, cast.....	7·807	Ebony	1·177	of Salt)	1·194
Iron, malleable	7·738	Oak, heart of, 60 years		Human Blood	1·054
— cast	7·207	felled	1·170	Milk, Cows'	1·032
Tin, cast	7·291	Pitch	1·150	Sea-water	1·030
— fine, cast	7·190	Rosin	1·100	Serum of Human Blood	1·030
Manganese	6·850	Mahogany.....	1·063	Ale	1·028
Antimony.....	6·702	Amber	1·040	Vinegar	1·026
Arsenic	5·8843	Brazil Wood.....	1·031	Tar	1·015
Natural Magnet	4·800	Beeswax	0·955	Water	1·000
Ponderous Spar (Sul-		Butter	0·940	Distilled Water	0·993
phate of Barytes)	4·430	Logwood	0·913	Oil of Aniseed	0·986
Oriental Ruby.....	4·283	Ash (dry)	0·838	Linseed Oil	0·932
Bohemian Garnet	4·188	Plumtree (dry)	0·826	Brandy	0·927
Oriental Topaz.....	4·010	Elm (dry)	0·801	Proof Spirit	0·916
Brazilian Topaz	3·536	Oak (dry)	0·800	Olive Oil	0·913
— Ruby.....	3·531	Yew	0·760	Oil of Turpentine	0·870
Diamond	3·521	Crabtree	0·760	Alcohol	0·794
		Beech (dry)	0·700	W. T. K.	

3. GASES AND VAPOURS, THAT
OF ATMOSPHERIC AIR BEING 1.

Atmospheric Air	1·000	Chloroprussic Acid	2·152	Nitrous Oxide.....	1·527
Ammoniacal	0·590	Cyanogen	1·805	Oxygen	1·111
Carbonic Acid	1·527	Enchlorine	2·440	Phosphuretted Hydro-	
— Oxide	0·972	Fluoboric Acid	3·371	gen	0·902
Carburetted Hydrogen..	0·972	Fluosilicic Acid	3·632	Sub-carburetted Hydro-	
Chlorine	2·500	Hydriodic Acid	4·340	gen	0·555
Chlorocarbonous Acid ..	3·472	Hydrogen	0·069	Sub-phosphuretted Hy-	
		Nitric Oxide	1·041	drogen	0·972
		Nitrogen	0·972	Sulphuretted Hydrogen	0·136
		Nitrous Acid	2·635	Sulphurous Acid	2·222

Brande's Dictionary of Science, Literature, and Arts, 1842. p. 529.

Apparently the simplest way for the determination of specific gravities of solids, would be to form samples of a uniform volume; as, for instance, one cubic inch. Their absolute weight, as determined by the balance, would be their specific gravities.

But in practice so many difficulties would be encountered in such a process, that its results would not furnish us with accurate information, whereas the principles of hydrostatics furnish us with far more accurate means for resolving such problems.

To determine the specific gravity of a solid body, it is to be weighed first in air and then in water.* In the latter instance it will weigh less than in the former, because it displaces a quantity of the water equal to its own volume, and this deficit in weight is the weight of the water so displaced. The weight in air and the loss in water being thus determined, to find the specific gravity, "Divide the weight in air by the loss in water, and the quotient is the specific gravity."

"If the body be lighter than water, there must be affixed to it some substance sufficiently heavy to sink it, the weight of which, and also its loss of weight in water, are previously known. Deduct this weight from the loss of the bodies when immersed together, and divide the absolute weight of the light body by the remainder; the quotient gives the specific gravity."

For the determination of the specific gravity of liquids several methods may be resorted to. One of the most simple is by the thousand-grain bottle. This consists of a light glass flask, the stopper of which is also of glass, with a fine perforation through it. When the bottle is filled with distilled water, and the stopper inserted in its place, any excess of liquid is forced through the perforation, and the bottle, on being weighed, should be found to contain one thousand grains of the liquid exactly.

If any other liquid be in like manner placed in this bottle, by merely ascertaining its weight we at once determine its specific gravity. Thus, if it be filled with oil of vitriol or muriatic acid, it will be found to hold 1,845 grains of the former and 1,210 of the latter. Those numbers, therefore, represent the specific gravities of the bodies respectively.

This instrument enables us to illustrate, in a very satisfactory manner, the effect of temperature on specific gravity. It has been said that the thousand-grain bottle is so called from its containing precisely one thousand grains of water; but very superficial consideration satisfies us that this can only be the case at a particular temperature.

* To find the specific gravity of bodies.

1. *If it be a solid body, heavier than water*, weigh it exactly, first in air and then in water, or some fluid whose specific gravity you know; and let the absolute weight of the body = A, the weight of the body in water, &c. = B, the specific gravity of water, &c. = C, the specific gravity of the body = D. Then will $D = \frac{A}{A-B} C$, the specific gravity of the body.

2. *For a solid body, lighter than water*. Take any piece of metal, and tie it to a piece of the light body, so that the compound may sink in water; and putting A, C, D, as in No. 1, and E = weight of the metal in water, F = weight of the compound in water. Then, $D = \frac{AC}{A+E-F}$ the specific gravity of the light body.

3. *For a fluid*. Take a solid body of known specific gravity, which will sink in the fluid, and putting the same letters as in No. 1; then will $C \frac{A-B}{A} D$, the specific gravity of the fluid.

—*The Principles of Mechanics*, by WILLIAM EMERSON, with Notes by G. A. SMEATON. 1836. pp. 115, 116.

Suppose the bottle is of such dimensions that at 60° Fahrenheit it contains exactly one thousand grains, if we raise its temperature to 70° Fahrenheit, the water will expand, or if we lower it to 50° Fahrenheit it will contract exactly as if it were a liquid in a thermometer. It is, therefore, very clear that temperature must always enter into these considerations, and that before we can express the relation of weight between any substance, whether solid or liquid, and that of an equal volume of water, we must specify at what particular temperature the experiment was made. For many purposes 60° Fahrenheit is selected, and for others $39\frac{1}{2}^{\circ}$ Fahrenheit, which is the temperature of the maximum density of water.

There is a second method by which the specific gravity of fluids may be known. It is to weigh a given solid (as a mass of glass) in the fluids to be tried, and determine the loss of weight in each case. Inasmuch as the solid displaces its own volume of the different liquids, the losses it experiences when thus weighed will be proportional to the specific gravities. The following rule, therefore, applies: "Divide the loss of weight in the different liquids by the loss of weight in water, and the quotients will give the specific gravities of the liquids under trial."

For the determination of the specific gravities of gases a plan analogous in principle to that of the thousand-grain bottle is resorted to. A light glass flask, exhausted of air, is attached by means of the stop-cocks to the jar, containing the gas to be tried. This gas has been passed through a drying-tube by means of a bent pipe into the jar over mercury. On opening the stop-cock the gas flows in, and its weight may then be determined by the balance.

From the greater dilatation of gases by heat, all that has been just said in relation to the effect of temperature on specific gravity applies here still more strongly. It is to be recollected that this form of bodies is compared with atmospheric air taken as the standard.

For gases another disturbing agency beside temperature intervenes—it is pressure. Atmospheric pressure is incessantly varying, and the densities of gases vary with it. It is not alone the thermometer, but also the barometer which must be consulted, and the temperature and pressure both specified. Besides, great care must be taken, in transferring the gas from the jars in which it is contained, that it is not subjected to any accidental pressures in the apparatus itself, and that the flask in which it is weighed is not touched by the hands or submitted to any other warming or cooling influences. [The determination of the specific gravity of gaseous substances is an operation of much greater delicacy. From the extreme lightness of gases, it would be inconvenient to compare them with an equal bulk of water, and, therefore, atmospheric air is taken as the standard of comparison. The first step of the process is to ascertain the weight of a given volume of air. This is done by weighing a very light glass flask, furnished with a stop-cock, while full of air; and then weighing it a second time, after the air has been withdrawn by means of the air-pump. The difference between the two weights gives the information required. According to the observation of Prout, 100 cubic inches of *pure and dry* atmospheric air, at the temperature of 60° , and when the barometer stands at 30 inches, weigh 31.0117 grains. By a similar method the weight of any other gas may be determined, and its specific gravity be inferred accordingly. For instance, suppose 100 cubic inches of oxygen gas are found to weigh 34.109 grains, its specific gravity will be thus deduced; as 31.0117 : 34.109 : : 1 (the specific gravity of air) : 1.1025, the specific gravity of oxygen.—"TURNER'S CHEMISTRY," Edited by BARON LIEBIG, 6th Edition, p. 191.]

(To be continued.)

MATHEMATICAL PROBLEMS.

1.

It is required to find two numbers, such that the cube-root of the greater being added to the square of the lesser, the sum shall be equal to the greater, and being subtracted therefrom, the difference shall equal the lesser.

2.

In any equilateral triangle A B C, inscribed in a circle, if from the vertex B, a line be drawn through the opposite side, and produced to meet the circumference of the circle in D, then A D and D C being joined, $A D + D C = B D$.

METEOROLOGY.

(Continued from page 18.)

PRESSURE OF THE ATMOSPHERE.

VARIATION IN LATITUDE. The *mean* or *average* pressure of the atmosphere, as indicated by the barometer, is found to be nearly the same in all latitudes, when every essential correction is made. It increases a little from the equator to about the 30th degree of latitude, where it is *greatest*; it then decreases to nearly the 64th degree, where it is *least*; after this it again increases, and between the 75th and 76th degrees, the pressure is equal to that of the equatorial climes. All this is obvious from the following Table, founded upon observations, where corrections are made for gravity, altitude above the sea-level, and temperature :

Places.	Latitude.	Height of Barometer.
		Inches.
Cape of Good Hope..	33° S.	29·955
Christianburg	5° 30' N.	29·796
Tripoli	33° N.	30·127
Godthaab	64° N.	29·598
Spitzbergen	75° 30' N.	29·801

The pressure of the atmosphere at any given spot is not invariable; for the height of the barometer is perpetually changing throughout the year. The extent of its fluctuations is, however, by no means the same in all places, being *least* at the *equator*, and *greatest* towards the *poles*. Thus its range within the tropics is but a little more than one-fourth of an inch; at New York, 40° 42' 40" N. lat. 2·265 inches, from the observations of five years; at St. John's, Newfoundland, 47° 34' 3" N. lat., 2·54 inches, during the same period; while in Great Britain it amounts to *three* inches. The greatest fluctuations occur between the 30th and 60th degrees of latitude.

There is also a constant *daily* variation in the atmospheric pressure; for the barometer, as a general rule, falls from 10 o'clock, A.M., to 4 P.M.; it then rises until 10 P.M., when it again begins to descend, reaching its lowest point at 4 A.M.; from this time it rises, until it once more

attains its highest elevation, at 10 A.M. These variations are exceedingly minute, and, contrary to the annual range, are *greatest* at the *equator*, and *decrease* with the *latitude*; disappearing about the parallel of 60°.

This variation amounts at

Places.	Latitude.	Inches.
Rio Janeiro	22° 54' S.	to ·067
Lima	12° 3' S.	to ·10
Calcutta.....	22° 35' N.	to ·072
St. Petersburg	59° 56' N.	to ·005

In the tropical regions, according to Humboldt, so regular are the diurnal changes, that the barometer indicates true time, within a quarter of an hour.

These daily fluctuations, in the atmospheric pressure, for a long time perplexed meteorologists; but their cause has, at length, been discovered, by means of the late observations at the English observatories. They are found to arise from the stated variations in temperature that occur during the day.

VARIATIONS IN ALTITUDE. As we ascend above the surface of the earth, we leave a portion of the atmosphere below us, and are freed from its pressure. This fact is denoted by the fall of the barometer. When De Luc, a French philosopher, ascended to the height of 20,000 feet, his barometer sunk to *twelve* inches. In 1838, the *aéronaut* Green, rose from Vauxhall gardens, in London, to an elevation of nearly three miles and three-quarters; the mercury in the barometer gradually descending from *thirty* inches to *fourteen* and *seven-tenths*.

As a general rule, this depression near the surface of the earth, amounts to *one-tenth of an inch for every eighty-seven feet* in altitude; but where perfect accuracy is required, several corrections must be made. The barometer then becomes, in the hands of skilful observers, an important instrument for determining altitudes; and so exact are its indications, that two independent estimates of the height of Mount *Ætna*, made by means of this instrument, differ only one foot; that of Capt. Smyth being 10,874 feet, while Sir John Herschel's is 10,873 feet.

DENSITY OF THE ATMOSPHERE. When one portion of the atmosphere is said to be more dense than another, all that is meant is simply this, that a *given volume, or bulk, of the first portion, as one gallon contains more ærial particles than an equal volume of the second*; thus, if it contains twice as many particles, it is said to be twice as dense.

The density of the atmosphere *decreases* with the *altitude*. This result is caused by the diminished pressure of the air, and the decreasing force of gravity. Imagine the atmosphere to be divided into a vast number of thin, concentric strata.

Now it is clear, that the particles in each layer *are pressed together* by the whole weight of the atmosphere above them; while, at the same time, they are *drawn together* by the force of gravity. Variations in the latter power are only appreciable at great distances from the earth; and the observed changes in density, at two or more stations, may therefore be ascribed to the difference in the weight or pressure of the superincumbent atmosphere. The *height* of the barometer, at different elevations, thus denotes the *density* of the air at these points.

The density, however, is not *exactly* proportioned to the pressure, slight modifications arising from several causes; the most important of which is *temperature*. The heat of the atmosphere decreases with the altitude; and since heat expands, and cold contracts, a given volume of air, $\frac{1}{480}$ th part of its bulk, at 32°, for every degree Fahr.; or, in other words, thus lessens and increases its density, a correction must be made for this influence.

It has been found by calculation, combined with observations, that, if the *altitudes are represented by an increasing arithmetical series, the densities of the atmosphere decrease in a geometrical progression*. Thus, if at the height of 18,000 feet, the air, as the barometer indicates, is but half as dense as at the surface of the earth; at 36,000 feet it will be reduced to one-fourth, and at 54,000 feet to one-eighth of its original density.

The rarefaction of the air, at lofty elevations, lessens the intensity of sound, impedes respiration, and causes the minute veins of the body to swell and open. Thus, at a short distance, the report of a pistol

upon the summit of Mont Blanc, can scarcely be heard. Gay Lussac, and Biot, ascending from Paris in a balloon, to the height of 25,000 feet, breathed with pain and difficulty; and upon the high table-lands of Peru, the lips of Dr. Tschudi cracked and burst; while the blood flowed from the veins of his eyelids.

In consequence of this diminution of pressure, water boils in such situations at a comparatively low temperature; thus, at Quito in Equador, 9,537 feet above the sea level, ebullition takes place at the temperature of 196° Fahr.

WEIGHT OF THE ATMOSPHERE. We have seen that a column of mercury, about thirty inches in height, weighs at the surface of the earth exactly the same as a column of the atmosphere, possessing the same base. If, then, the globe was covered with an ocean of mercury thirty inches in depth, the latter would occupy the identical base that the atmosphere does now, and their respective weights may be regarded as equal.

Under this supposition, the diameter of the earth would be increased five feet. The difference then, in cubic feet, between the solidity of the earth and that of a globe whose diameter is five feet greater, will equal the number of cubic feet in the *sea* of mercury. This number multiplied by the weight of a cubic foot of mercury, viz. 848,125 lbs., will equal that of the whole mass, which is the same as the weight of the atmosphere. This calculation has been made, and amounts to more than *five thousand billions of tons*.

TEMPERATURE OF THE ATMOSPHERE. The entire body of air surrounding the globe appears to be warmed in *two* ways; first, by the luminous beams of the sun; secondly, by the radiation of heat from the earth.

According to Kaemtz and Martin, the atmosphere absorbs nearly one-half the daily amount of heat, which emanates from the sun to the earth, even when the sky is perfectly serene. The remaining portion falling upon the surface of the ground, elevates its temperature, and the earth sends back into the atmosphere rays of invisible heat.

Modern researches have shown that all bodies, through which heat can pass, absorb a greater proportion of non-luminous

than of luminous calorific rays. The heat, therefore, that radiates from the earth, will not pierce the atmosphere, with the power of the solar ray; all will be retained by the lower strata of air, which in their turn diffuse invisible thermic rays in every direction.

We thus perceive what all observations have proved, that the upper regions of the atmosphere must be colder than the lower. It is not, however, to be forgotten, that the rarefaction of the superior strata contributes to this condition.

THERMOMETER. The temperature of the atmosphere is indicated by the *thermometer*; an instrument which derives its name from the Greek words, *thermos*, warm, and *metron*, measure. It consists of a small glass tube, terminated by a bulb, and is partially filled with mercury.

This fluid is usually preferred for several reasons; the most important of which are, its *uniform dilation*, its *quick susceptibility* to any change in temperature, and the *great range* of its *expansion* in the fluid state. If the instrument is to be exposed to extreme cold, alcohol must be used.

As mercury, like other fluids, expands by heat, and contracts by cold, its alternate elevations and depressions within the tube can be made to indicate the corresponding changes in the state of the air, if *two fixed temperatures can be found, whence to reckon the changes*. These have been discovered. If a thermometer is immersed at different times in *melting snow*, the column of mercury invariably sinks to the same place in the tube, though many months may have elapsed between the experiments; and when exposed to the steam of *boiling water*, the mercury always ascends to the same height, under the same atmospheric pressure.

These invariable positions, which are termed the *freezing* and the *boiling* points, are marked upon the scale to which the tube is affixed. In Fahrenheit's thermometer, figure 3, the interval between them is divided into 180 parts, each of which is called a degree (1°), and as the freezing point is marked 32° , the boiling is therefore 212° . The divisions are extended downwards from 32° to 0, or the *zero* point, and when extreme degrees of cold are to be measured, the range is continued to 20° , 40° , and even 60° below zero. If

the air is colder than 40° below zero, a spirit thermometer must be used, since mercury becomes solid at this temperature. When Simpson, a late northern traveller, wintered in 1838, at Fort Confidence, 67° N. lat., he cast a bullet of mercury, the

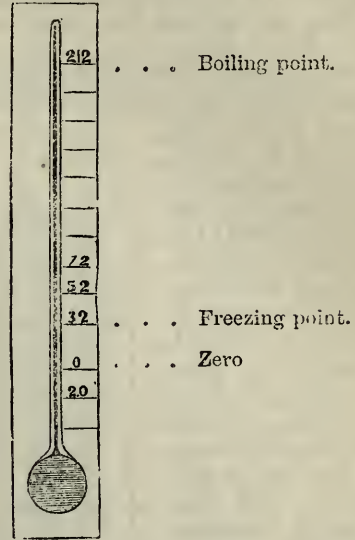


Fig. 1.

temperature being 49° below zero. Upon firing the ball, it passed through an inch plank, at the distance of ten paces; but flattened and broke against the wall three or four paces beyond. In addition to the mode of graduation adopted by Fahrenheit, several others prevail (*C. 570*), which it is not necessary here to discuss.

The thermometer employed for meteorological purposes should be made as accurate as possible; and in order to ensure its perfection, many niceties must be observed in its construction.

FIRST. *The tube should be of equal size throughout the whole stem; else the same increase of temperature will not produce the same increase in the height of the mercury throughout every part of the tube; and so of the decrease.*

SECONDLY. *The bulb should be large in proportion to the tube; for then slight changes in temperature will be rendered perceptible, and the delicacy of the instrument increased.*

THIRDLY. *The mercury should be pure dry, and recently boiled, in order to free it*

from air ; and, when in the tube, should there again be boiled, to drive off any air or moisture collected within.

LASTLY. *When the mercury is at the summit of the tube, and every thing else has been expelled, the top of the tube must be perfectly closed by the fusion of the glass, leaving, when the mercury has cooled, a void space or vacuum above.*

When a thermometer has been exposed to great changes in temperature during the course of a year, the position of the freezing point upon the scale is found to be somewhat altered ; for if the instrument is then placed in melting snow, the mercury is usually seen to stand a little higher than 32° , and less than 33° . This change would occasion a constant error in the observations ; and meteorologists therefore verify their thermometers at stated intervals, in the way just mentioned.

SELF-REGISTERING THERMOMETER. The object for which this instrument is constructed, is to obtain in the absence of the observer the highest and lowest temperature of the day, or of any other interval of time.

One of the most correct thermometers of this kind now in use, is that invented by Mr. James Six of Colchester, which is represented in Fig. 2.

It consists of a long glass bulb, G, narrowing into a fine tube, which is first bent downward, forming the arm *a b*, and then upwards, forming the arm *c d*, which terminates in a small cavity, L. The two arms contain mercury, which extends down from *a* on one side, and up to *c* on the other : the bulb and the rest of the tube are filled with alcohol, except the upper

part of the cavity, L. Upon the top of the mercury in each arm rests an index (which is more perfectly seen at A), consisting of a piece of iron wire, capped with enamel, and loosely twined with a fine glass thread ; when the mercury descends, the index would fall were it not for the glass thread, which, pressing like a spring against the sides of the tube, supports the index in any position.

The action of the instrument is as follows : When an increase of temperature expands the spirit, the mercury is depressed in the arm *a b*, and elevated in *c d*, carrying the index up with it. If the temperature now falls, the spirit contracts, and the mercury descends in *c d* ; but the index remains in its last position, from the pressure of the glass spring against the tube ; and, as it does not fit tightly to the latter, the alcohol above it flows readily by.

As the cold augments, the mercury rises in *a b*, bearing up the index of this arm, until an increase of temperature occurs, when the mercury here falls, and the index continues stationary. Thus, the highest point to which the index rises in the arm, *a b*, indicates the least temperature, and that in *c d*, the greatest, that happens in any interval of time, as a day, or a year ; and the scale, as is evident from the figure, is graduated accordingly.

After every observation, each index requires to be adjusted ; this is done by means of a magnet, which, being moved down the side of the arm, draws the index after it.

(To be continued.)

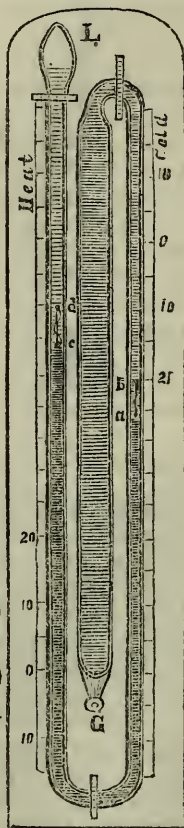


Fig. 2.

THE COURSE OF LIFE.—Like flakes of snow that fall unperceived upon the earth, the seemingly unimportant events of life succeed one another. As the snow gathers together, so are our habits formed. No single flake that is added to the pile produces a sensible change ; no single action creates, however it may exhibit a man's character ; but as the tempest hurls the avalanche down the mountain, and overwhelms the inhabitant and his habitation, so passion, acting upon the elements of mischief, which pernicious habits have brought together by imperceptible accumulation, may overthrow the edifice of truth and virtue.—*Jeremy Bentham.*

CHEMISTRY.

(Continued from page 78.)

WEIGHT AND SPECIFIC GRAVITY.

At every step of research the chemist must appeal to his balance. This instrument should possess a beam, inflexible by the weight intended to be used, and should be delicately poised on a sharp edge of hardened steel (called the knife-edge), resting on a plate of agate, mounted on the summit of an upright pillar of brass. The beam should be so accurately made that it will assume a horizontal position when at rest, its index or pointer marking zero, on the small scale near the foot of the column. At each end of the beam is also a knife-edge supporting the scale-pan, and in a delicate balance there is always an adjustment by which, when the instrument is not in use, the beam is

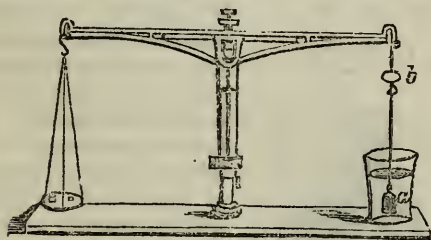


Fig. 14.

supported on points independent of the delicate knife-edge, which is thus saved from unnecessary wear. A good balance will turn readily with a weight of one-thousandth part of a grain, when each arm supports one thousand grains. In delicate weighing, a glass-case is employed to protect the balance from the fluctuations of the atmosphere. When accurate results are required with a balance whose arms are of unequal length, or which is from any cause inaccurate, the method adopted is to weigh the substance accurately in each pan, and to take the mean of the two weighings, which will give the true weight; or the substance being placed in one pan, is counterpoised accurately by the addition of shot or bits of foil in the other: it is then removed, and its place supplied by known weights till the equilibrium is restored. The weights added give the weight of the substance. The above figure shows the form of a good

balance, arranged for taking specific gravities. One pan is removed, and a shorter one (*b*) substituted, from which by a silk thread the substance (*a*) is supported in a glass of pure water.

It is always assumed, when the weights of substances are stated in books of science, that the operation was performed at a given temperature by the thermometer; and 60° of Fahrenheit's scale is the point agreed upon, because that is about the usual temperature of the air; and if it be higher or lower, a corresponding allowance is made, because the bulk, and, consequently, the specific weight of bodies, differ with their temperature. This precaution is necessary only when we take the specific gravity of bodies, and not their absolute weights.

Density.—The *density* of a body is a direct result of the law of gravity, the weight of a body being the measure of the force of gravity, which is directly proportioned to the quantity of matter. The greater the number of particles of a given kind within a given space, the greater the density of the body, or in the language of common life, the *heavier* it is. Now as bodies differ greatly in this particular, each body is said to have a *specific gravity*, or density, peculiar to itself.

Specific Gravity.—The *specific gravity* of a body is its weight, compared with that of some other body of exactly equal volume. We say that lead is heavier than cork; by which we mean, that of equally sized pieces of these substances, one is very many times heavier than the other; that is, there is very much more matter in the one than in the other under equal dimensions. As a difference in specific gravity in bodies is found to be accompanied by other important differences, we will give an account of the methods of determining this character in liquids, solids, and in gases.

Standards of Specific Gravity.—Pure water at a temperature of 60° is the substance which has been adopted as a standard of comparison for the specific gravity of all solid and liquid substances, while the dry atmospheric air at 60° of Fahrenheit and 30 inches of the barometer is the standard assumed for all gases and vapours. Thus calling water 1, lead will be 11·445, or lead is nearly eleven and a half times as heavy as water. Cork is lighter than

water, and must be expressed by a fractional number. Oil of vitriol (sulphuric acid) has a specific gravity of 1.847 when pure, or nearly twice as much as water. A pint measure of this dense liquid would weigh nearly twice as much as a similar measure of water; while a pint of quick-silver would weigh thirteen and a half times as much as a pint of water, and a like measure of alcohol only about three-quarters as much (0.794 being the specific gravity of alcohol). We see now the necessity of knowing accurately the temperature of substances compared, at the time of weighing, as their bulk increases materially with every increase of temperature, and their specific gravity consequently diminishes.

Specific Gravity of Liquids.—To measure the specific gravity of liquids accurately, a small thin glass bottle is required, which holds a known weight of pure water at 60° when accurately filled. One thousand grains is a convenient quantity for comparison; but a smaller quantity is often more convenient, when we have



Fig. 15.

but little of a substance, although it then requires a simple calculation to reduce it to the standard. To its neck a glass stopper is adapted, by grinding, which is perforated by a small hole. The weight of the bottle is counterpoised by a small mass of lead, which is easily cut by a knife to the exact weight. This counterpoise is carefully preserved for this purpose. The bottle is now ready for use; it is filled with the fluid under examination, the stopper is carefully introduced, and the excess of the liquid gushes out through the small orifice. The exterior of the bottle is wiped dry, and its weight, when thus filled, is ascertained; and if the bottle is graduated to 1,000 grains of pure water at 60°, the weight obtained is the specific gravity. For instance, if the fluid is pure



Fig. 16.

ether, the 1,000-grain bottle, when filled, would weigh only 720 grains, and 720 is the specific gravity of ether. As, however, it may not be always convenient to procure a thousand-grain bottle (as Fig. 15) any glass phial may be converted into one, which will answer the purpose very well. Suppose it to contain 376 grains of pure water: then, as 376 : 1,000, so is the weight obtained to the specific gravity of the fluid. A little bottle like that in Fig. 5, answers the same purpose, although in a less accurate manner than with the perforated stopper. Its neck is quite narrow, and the lines marked on it show the upper and lower surfaces of the liquid in the neck. The quantity of pure water which it holds at this point is learned from previous trials.

Specific Gravity of Solids.—The determination of the specific gravity of solids is founded on the theorem first proved by Archimedes, *that when a solid body is immersed in water, it loses a portion of its weight exactly equal to the weight of the water displaced.* The story in which it is stated that this philosopher detected the fraud of King Hiero's

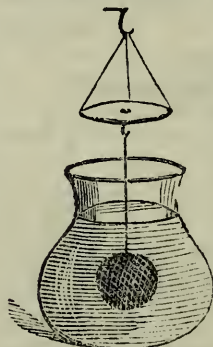


Fig. 17.

goldsmith, in furnishing to the monarch, as a crown of pure gold, one made of a debased metal, is a good example of the practical value of this theorem. In fact, plunging an irregular solid into water, is the only mode by which we can easily and accurately measure the precise bulk of the body as compared with an equal bulk of water. For convenience in taking the specific gravities of solids, a small scale-pan is hung to one arm of the balance, (as shown in Fig. 14,) and the instrument brought to a perfect equilibrium. A hook is attached to the lower surface of this pan, for suspending a thread. It is required to take the specific gravity of a piece of lead. The specimen is attached by a filament of raw silk, or a fine hair, with a noose at the end, to the hook, and the actual weight of the mass hanging in the air accurately determined.

But, in order to have its weight as compared with water, we must know precisely how much a mass of water will weigh, which is just equal in bulk to the specimen. Now if we suspend it as it hangs from the scale-beam in a vessel of pure water, we shall displace just such a quantity of water as corresponds with the bulk of the lead, and no more; the water will buoy up the specimen by a weight just equal to a like bulk of water: in other words, the specimen will weigh less in water than it did in air; and we must diminish the weight on the other side of the beam, to correspond with this loss of weight. If we now subtract from the weight in air, that which we have found to be its weight in water, the difference will evidently give us the weight of a bulk of water exactly equal to the bulk of our specimen. As water is the standard of comparison which has been adopted for specific gravity, if we divide the actual weight of the substance in air by the weight of an equal bulk of water, we shall have the specific gravity sought.

We deduce the following rule for determining specific gravity. Subtract the weight in water from the weight in air, divide the weight in air by the difference thus found, and the quotient will be the specific gravity. We find on trial that the

Weight of the substance in air	is 357.95 grs.
Weight of the substance in water	„ 239.41 „
Difference	118.54 „
$\frac{357.95}{118.54} = 3.01$ specific gravity.*	

* *Nicholson's Aræometer.*—A cheap and convenient substitute for the balance is found in a little instrument represented in Fig. 18, and called *Nicholson's Aræometer*, which we will briefly describe. V is a metallic ball or float having a descending hook, to which is hung a little weighted pan *l* to hold the substance which is weighed in water; the wire stem *f* supports a cup *c*. A mark *t*, on the stem, shows the point at which the whole apparatus will float in a tall vessel of water, when a certain known weight (called the balance-weight) is put in the cup *c*. The specimen under examination must not exceed in weight the balance-weight, this being the limit of the instrument. Suppose the limit to be 100 grains. To find by this instrument the specific gravity of a substance, place it on *c*, and add weights till the instrument sinks to the mark *t*,



Fig. 18.

Substances which are lighter than water can have their specific gravity taken, by attaching to them any convenient bit of metal which will sink them; the weight of the substance is taken in air, and then the united weight, after attaching the piece of metal. The weight in water of both united is now taken, and the light body being detached, the weighing is repeated on the metallic body.

For this purpose we may also take some liquid in which the light body will just float, and then determine the specific gravity of the fluid by the bottle (§ 40), which will give us at once the specific gravity of the solid. Thus, if we put a lump of wax into water, it will float above the surface; but in pure alcohol it will sink. If we dilute the alcohol by small doses of water, we shall soon find a point when the wax will just float, or rise and sink indifferently. The alcohol at this state of dilution has the same specific gravity as the wax, and this we find, by the specific gravity bottle, to be about 0.9.

If a substance is in powder or in small grains, its specific gravity is found by taking a known weight of it, and having introduced it into the specific gravity bottle for fluids, to fill it with pure water and weigh; the weight of the substance being deducted from the weight of the whole contents of the bottle, the difference between the sum thus obtained and the weight of the water which the bottle alone

the added weight being subtracted from 100, gives the weight of the specimen in air. Now place the specimen in the pan *l*, and again add weights to *c*. As much more weight on *c* will now be required as corresponds to the weight of a bulk of water equal to the specimen, which, it must be remembered, is buoyed up by a power just equal to such weight. The difference of weight thus found will be the divisor of the weight of the specimen, and the quotient will be the specific gravity sought.

This instrument is generally made of brass or tin-plate, but may be more elegantly made of glass.

For example, put the specimen in	
Balance weight = ...	100.00
Weights added to sink instrument to <i>t</i> = ...	22.57 grs.

Weight of specimen in air = ..	77.43
Specimen placed in lower pan	
requires additional weights =	35.43
35.43—22.57=12.86, the weight of a like bulk of water; then $\frac{77.43}{12.86} = 6.02$, the specific gravity sought.	

will hold, corresponds with the difference between the weight of the substance in air and water. For instance, we introduce 100 grains of a powdered mineral into a specific gravity bottle, holding 1,000 grains of pure water, and fill the remaining space with water at 60°. We might expect that we should have a weight of 1,100 grains, but find only 1,059, the place of some of the water being occupied by the powder introduced:

The bottle holds 1,000 grains.
 Substance introduced weighs .. 100

Weight found 1,100
 1,059

Difference 41
 $\frac{41}{100} = 2.044$, the specific gravity sought.

If the substance is soluble in water, we must employ a fluid of known specific gravity, in which it is not soluble. For instance, sugar cannot be weighed in water, but in absolute or pure alcohol it can. The specific gravity being determined in a fluid whose specific gravity, as compared with water, is known, it is easy, by a simple proportion, to tell the specific gravity of the solid.

The *Hydrometer* is an instrument of great use in determining the specific gravity of liquids without a balance. It is simply a glass tube with a bulb blown on one end of it, containing a few shots or some mercury, to counterbalance the instrument, while a scale of equal parts (*a*) is made of paper and introduced into the open end, which is then tightly sealed. This scale indicates the points to which the stem sinks when immersed in fluids of different densities. The fluid for convenience



is placed in a tube or narrow jar (like the one shown in Fig. 19); the more dense the fluid, the less quantity will the hydrometer displace, while in a lighter fluid it will sink deeper. The zero point of the scale is always placed where the instrument will rest in pure water, after which the graduation is effected on a variety of arbitrary scales, all of which can, however, be referred to the true specific gravity, by calculation. The scales of these instruments read either up or down, according as the fluid to be measured is

either heavier or lighter than water. In case of alcohol (it being lighter than water), the graduation of the hydrometer is made to indicate the number of parts of pure alcohol in a hundred parts of the liquid, absolute alcohol being 100, and water 0. The hydrometers of Baumé (a French maker), are much used in the arts. These instruments are of the greatest service to the manufacturer, and when carefully made are sufficiently accurate for most purposes of the laboratory. They should always be proved by comparison with the balance before they are accepted as standards. For many purposes they are made of brass or ivory, as well as of glass.

Little balloons or bulbs of glass are frequently employed to find, in a rough way, the density of fluids. When several of them are thrown in a fluid of known density, some will sink, some rise even with the surface, and others will just float. Those which just float are taken, and being marked (as in Fig. 20),

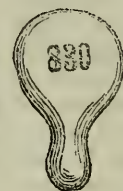


Fig. 20.

with the density of the liquid which they represent, are then used to determine the specific gravity of liquids of unknown density. They are called specific gravity bulbs, and are of great service in ascertaining the density of gases reduced to a liquid by pressure in glass tubes, when, from the circumstances of the experiment, all the usual modes of ascertaining specific gravity are inapplicable.

Specific Gravity of Gases.—It remains only, under this head, to speak of the modes used for determining the specific gravity of gases and vapours. For this purpose a globe, or other conveniently formed glass vessel, holding a known quantity by measure (usually 100 cubic inches), is carefully freed from air or moisture, by the air-pump or exhausting syringe, and is then filled with the gas or vapour in question, and at 60° Fahrenheit, and thirty inches of the barometer, and weighed; the weight of the apparatus filled with common air being previously known, the difference enables the experimenter

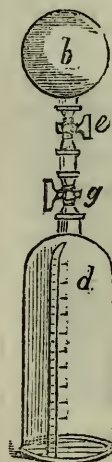


Fig. 21.

to make a direct comparison. The annexed figure shows an apparatus for this purpose; the globe (*b*) is provided with a stop-cock (*e*), and fitted by a screw to the air-jar (*d*). The jar is graduated so that the quantity of air or other gas entering may be known from the rise of the water in *d*. It is thus found that 100 cubic inches of pure dry air weigh 31·0117 grains, while the same quantity of hydrogen gas weighs only 2·14 grains, being about fourteen times lighter than air.

SYSTEM OF ELOCUTION.

(Continued from page 73.)

Stammering.—Stammering is a functional derangement of the organs of speech, which renders them incapable, under certain circumstances, of promptly obeying the commands of the will.

In a majority of cases, the cause of this affection operates through the medium of the mind.

Stammering is cured by a regular course of hygienic elocution. But, as the disease exists under a variety of forms, it requires a variety of treatment. And, as the treatment is medico-elocutional, he who would apply it successfully, must unite the skill of the elocutionist with that of the physician. The idea that non-medical men are capable of discharging the duties of applying the remedies to complicated complaints of the human body, is a *sui generis* in logic, and a bane in the practice of the healing art.

Stammering or stuttering is a hesitation or interruption of speech, and is usually attended with more or less distortion of feature. This affection presents itself under a variety of forms; but my limits will not allow me to give a particular description of them. I will notice only the most striking.

In some cases, the stammerer makes an effort to speak, and all his breath is expelled without producing vocality; in others, the lips are spasmodically closed: these two forms often occur in the same case. Sometimes the stammerer, while speaking or reading, loses all power over the vocal organs, and remains some moments with his mouth open, before he can

recover sufficient energy to proceed. In many cases, the stammerer repeats the word immediately preceding the one he is attempting to pronounce, or he repeats, in a rapid manner, the first element, or the first syllable, of the difficult word.

CAUSES.—The *predisposing* causes are nervous irritability and delicacy of constitution.

The most usual *exciting* causes are diffidence, embarrassment, a fear of not being successful when about to make an effort to speak, an attempt to speak faster than the vocal organs can assume the proper positions for utterance. Two or more of these causes often occur in the same case. Sometimes the habit of stammering is acquired by imitation.

The *proximate* cause of stammering is a spasmodic action of the muscles of speech.

PROGNOSIS.—The probability of a cure depends upon the following circumstances:—If the stammerer has a cheerful disposition, is distinguished for energy of mind and decision of character, can appreciate the variations of pitch in speech and song, or, in other words, has an ear for music, and a taste for elocution, the prognosis is favourable. But if he is of a nervous temperament, subject to melancholy, irresolute of purpose, incapable of imitation in speaking and singing, the prognosis is unfavourable.

TREATMENT.—The stammerer should be impressed with the importance, nay, necessity, of giving exclusive attention to the subject; and he should not be allowed to converse with any one till he can speak without stammering. These rules cannot be too strongly enforced. I am fully persuaded of this from my own experience. Several stammerers, who have placed themselves under my care, taking but two or three lessons a week, and attending to their usual avocations, have left me disappointed; while those who have given undivided attention to the subject, have been entirely relieved. True, many are more or less benefited even by occasionally taking a lesson; but it is very difficult, by any irregular course, to effect a radical cure. The habit of stammering should be arrested at once; for, while it is continued, how is it possible that the habit of speaking correctly can be established?

Great pains should be taken to inspire the stammerer with confidence. He should be convinced that his success depends mainly upon his own exertions: that he must pursue the various exercises assigned him with indefatigable zeal, with untiring industry; that he has the same organs of speech as other people, and nothing is necessary to enable him to use them as well, but a conviction in his ability to do so. To think that one *can* do, gives almost the ability to accomplish—but to think that one *cannot* do, virtually takes away the ability to do, even where it is ample.

Stammering is often continued by the subordinate estimation which the stammerer puts upon himself. He is too apt to consider those around him giants, and himself a dwarf. As this estimation of himself serves to perpetuate his disease, it is clear that its remedy must be found in making himself equal to any: if this mental classification into giants and dwarfs must take place, let the stammerers make themselves the giants, and those around them the dwarfs.

The teacher should study the disposition of his pupil: he should persuade him to banish from his mind all melancholy thoughts—in short, he should do everything in his power to render his pupil cheerful and happy.

Various athletic exercises should be resorted to daily, to invigorate all the muscles of voluntary motion, and diminish nervous irritability. In some cases it may be necessary to have recourse to tonics, anti spasmodics, bathing in salt-water, frictions over the whole surface of the body, &c., &c. Electricity may be used with advantage as a tonic, and also as a means of interrupting the spasm of the vocal organs.

The vocal treatment is deduced from the following circumstances:

1. An ability to sing.
2. An ability to speak when alone.
3. And if the stammerer must speak before an audience, the smaller the audience and the farther he is removed from it, the better.
4. An ability to speak amidst a noise that is sufficient to render the human voice nearly or quite inaudible.
5. An ability to speak better in the dark than in the light.

6. An ability to speak in a measured manner.

7. An ability to speak in a drawling manner.

8. An ability to speak with the mouth more or less distorted.

9. An ability to speak in any key, either higher or lower than that in which the stammerer usually converses.

10. An ability to speak with a halloo.

11. An ability to speak when the attention is divided or arrested by some object or circumstance, more or less irrelevant to the subject.

12. An ability to speak in concert or simultaneously. Everyone who has learned to sing, knows how much easier it is to sing in concert than alone. All the exercises, therefore, for the cure of stammering, should, at first, be conducted in concert.

Stammering may be considered a fault in elocution, the result of defective education, and is confirmed by habit. If children were properly instructed in speaking and reading, this affliction of the vocal organs would, probably, seldom or never occur. Hence, no mode of treatment that is not founded in just elocution or the correct exercise of the organs of speech, for the purposes of vocal expression, can be relied on. This must appear obvious to every intelligent and reflecting mind. The stammerer must be taught how to give language the pitch, time, and force which the sense requires. To effect this, his muscles of speech, which have long been refractory, must be trained till they are brought under the control of volition; and, like a well-marshalled troop of soldiers, made to act in harmonious concert.

Oral language may be resolved into certain sounds which are its elements. Now there are certain positions of the organs of speech, more favourable than others for the production of the elements. The stammerer should be made thoroughly acquainted with these positions, and, in connection with them, should be required to exercise his voice in the most energetic manner, upon all the elements singly, till he can utter them without hesitation. He should also utter them in various combinations, not only according to the laws of syllabication, but in every irregular way.

The vowels should be exploded from the throat with great force; and they should be sung, as well as pronounced with the rising and falling inflection, through every interval of pitch within the compass of the voice.

The pupil should be drilled in various exercises whose highest peculiarity is time and force. Time may be measured by means of the Metronome, by beating with the hand, and by marching, also by beating with the dumb-bells. Pitch, time, and force, are the elements of expression, and a proper combination of them in reading and speaking, constitutes good elocution. When, therefore, the stammerer becomes master of these elements, as well as the elements of the language, he may commence speaking and reading. In his first attempts at conversation, both teacher and pupil should speak in a deliberate manner, with a full, firm tone of voice, and in a very low pitch.

The stammerer should now commit to memory a short piece which requires to be spoken with explosive force; for example "Satan's speech to his legions." The members of the class should stand at a sufficient distance from each other to prevent their hands coming in contact when their arms are extended. They should then pronounce the speech in concert, after the teacher, and accompany it with appropriate gesticulation. It should be repeated again and again, till each pupil can give it proper expression, both as regards voice and gesture. Each pupil should then, in turn, take the place of the teacher and give out the speech to the class. To prevent the pupil's stammering, while he is performing the teacher's part, the teacher himself should play an accompaniment on the violin-cello, violin, organ, drum, or some other instrument. At first the notes should be made very loud; but if the effort of the pupil, standing out of the class, is likely to be successful, they should gradually be made softer and softer, and finally, the accompaniment omitted altogether. This piece should be pronounced alternately with one which requires to be spoken with long quantity and in a low pitch, as "Ossian's Address to the Sun."

When the pupil has mastered these two kinds of reading, he may take up dignified

dialogue, and, lastly, conversational pieces. He should draw out difficult words, which are generally those having short vowels preceded by labials, dentals, and gutturals.

In very bad cases of stammering, the pupil should first sing the words, then draw them, then pronounce them with very long quantity, and thus gradually approximate to common speaking.

As soon as the pupils can speak without stammering, they should recite singly in a very large room, or in the open air, at a distance from the audience, which, at first, should consist of the members of the class only. A few visitors should be occasionally introduced, and the number should be gradually increased. In this way, the stammerer will soon acquire sufficient confidence to speak before a large assembly. In some cases it may be expedient for the stammerer to recite before an audience in a dark room; but as he acquires confidence, light should be gradually admitted.

Stammerers, instead of speaking immediately after inspiration, as they should do, often attempt to speak immediately after expiration, when, of course, they have no power to speak. The lungs, like a bellows, perform their part in the process of speaking, best, when plentifully supplied with air. This is an important fact, and should be remembered, not only by stammerers, but also by those who have occasion to read or speak in public. Loud speaking, long-continued, with the lungs but partially distended, is very injurious to these organs: it is apt to occasion a spitting of blood, which is not unfrequently a precursor of pulmonary consumption. But loud speaking, with proper management of the breath, is a healthful exercise: besides strengthening the muscles which it calls into action, it promotes the decarbonization of the blood, and, consequently, exerts a salutary influence on the system generally.

(To be continued.)

THE wisest and happiest man is he, who, by constant attention of thought, discovers the greatest opportunity of doing good, and with ardent and animated resolution breaks through every opposition that he may improve these opportunities.

LESSONS IN FRENCH.

(Continued from page 84.)

OF THE PARTITIVE WORDS *SOME* AND *ANY* EXPRESSED OR UNDERSTOOD.

COMMON nouns, instead of being used either in reference to the whole extent of their signification, or limited to designate a distinct class of individuals or things, or to point out a single individual or thing of a whole class, may be employed only to express an indefinite part of a whole; they are then said to be used partitively. The words used in English to express this particular view of the mind are, *some* and *any*, which are thus called partitive words. The partitive word in French is the preposition *of*, *de*, followed or not by the article *the*, according to the following rules:

(1.) If the sentence is affirmative, and the noun be used in a partitive sense is not preceded by an adjective, *some* or *any* is expressed as *of* the should be, before the same noun, as follows:

Give me some bread.	Donnez moi <i>du</i> (de le) pain.
Give me some beer.	Donnez moi <i>de la</i> bière.
Have you any water?	Avez-vous <i>de l'eau</i> ?
Have you any apples?	Avez-vous <i>des</i> (de les) pommes?

The reason for this rule is to be found in the definition of the article itself; for when I say, *give me some bread*, I mean, *give me a part of the bread which you have* or *which is there*, the noun *bread* is then limited in my mind, and therefore definite, and requires the article *the* to be used with the partitive preposition *of*. Usage having suppressed the words *a part* and *which you have*, there remains the idiomatical expression, *Give me of the bread*.

(2.) If, the sentence being affirmative, the noun to be used in a partitive sense were preceded by an adjective, *some* or *any* should be expressed by the partitive preposition *of*, *de*, alone, without the article, as follows:

Give me some good bread.	Donnez moi <i>de bon</i> pain.
Have you any good apples?	Avez-vous <i>de bonnes</i> pommes?

But should the adjective follow the noun, instead of preceding it, the preceding rule does not stand good, and

some or *any* are expressed by *of the*, as follows:

Give me some white bread.	Donnez moi <i>du</i> (de le) pain blanc.
Have you any red apples?	Avez-vous <i>des</i> (de les) pommes rouges?

Why this difference? Is it because the expression, *good bread*, *bon pain*, is indefinite, and *white bread*, *pain blanc*, definite, that the article *the* is used in the latter case and suppressed in the former? Not at all. The reason for this difference between these two expressions arises from the fact that words being used in a sentence only to obey the impulse of the mind, the order in which they are placed, or their omission, is the consequence of that want. Thus, when I wish to say, *give me some good bread*, after having pronounced the first two words, *give me*, the idea which preoccupies my mind next, is that of *goodness* represented by the adjective *good*, which, expressing a mere qualification, is by its nature indefinite, and I do not feel prompted to use the article *the*, which always announces a definite idea; I say then, *give me of good bread*, thus making use of the partitive preposition *of*, which shows that I only want a part of the bread, and omitting the article *the*; but when, on the contrary, the noun precedes the adjective, as in, *give me some white bread* (*bread white*, in French,) the first idea which strikes my mind after having pronounced the words *give me*, is that represented by the word *bread*, which, being a noun, is most generally definite, and therefore I feel prompted to use the sign which precedes all definite nouns, that is to say, the article *the*; and I say, *give me of the bread white*. Such is, no doubt, the original cause of the introduction of this apparent discrepancy, which causes a Frenchman to say, *Donnez moi de bon pain*, and *donnez moi du pain blanc*; and from this habit—adopted from the time of the origin of the language—has originated the rule mentioned above, which grammarians have recorded in their works, and which has become a law in our language.

Remarks. It sometimes happens that we wish to fix the attention on the noun, in order that it should become the predominant idea; then, in such cases, and against the preceding rule, the article *the*

is used with the preposition *of*, *de*, before the adjective which precedes the noun used in a partitive sense, as, *This is real poetry*; *Voici de la vraie poésie*. *This is sound philosophy*; *Voilà de la bonne philosophie*.

We say, *J'ai du meilleur pain*, meaning, I have *some* of the best bread. *J'ai de meilleur pain que vous*, meaning, my bread is better than yours. *Tirez de meilleur vin*, meaning, Draw some better wine, and, *Tirez du meilleur vin*, meaning, Draw some of the best wine. The first and the last of these sentences express an idea in the superlative degree; the two others are mere comparative and do not require the article.

(3.) If the sentence is negative, whatever may be the situation of the noun to be used in a partitive sense, whether preceded or followed by an adjective or employed without any, the partitive meaning is conveyed by the preposition *of*, *de*, alone, as follows:

I have no (or not any) *Je n'ai pas de pain*.
bread.

Have you no (or have N'avez - vous pas *de*
you not any) apples? *pommes*?
I have no good bread. *Je n'ai pas de bon pain*.
I have no white bread. *Je n'ai pas de pain blanc*.

In these sentences, the unqualified nouns *pain* and *pommes*, and the qualified noun *bon pain*, and *pain blanc*, are only used as the names of the substances so called, without any reference to the extent of their signification; they are therefore indefinite, and employed without the article.

Remark 1st. But if we wish to fix the attention upon the noun, or to express strong opposition between two ideas, the article is used with the preposition, although the sentence is negative, as in,

I will not write you use- *Je ne vous écrirai pas*
less letters, but I will *des lettres* inutiles —
try to do useful things *mais je tâcherai de*
which may perhaps *faire des choses utiles*,
please you. *qui puissent vous*
amuser.

I will not address you *Je ne vous ferai point des*
frivolous reproaches. *reproches* frivoles.

Remark 2nd. When the sentence is negative and interrogative, the article is sometimes used and sometimes not; as,

Have you not some N'avez-vous pas *du pain*
bread for your break- *pour déjeuner*? — *De*
fast?—What do you *quoi* vous *plaignez*
complain at? *vous*?

Have you no bread?— N'avez-vous pas *de pain*?
I will give you some. — *Je vais vous en don-*
ner.

In the first case, although the sentence is negative, the meaning is affirmative: You have some bread, and I know it; in the other the sentence is dubitative; I do not know if you have any bread or not. We say according to the same principle:

I have money, but it is *Je n'ai pas de l'argent*
not to spend it fool- *pour le dépenser folle-*
ishly. *ment*.

(4.) But if the noun preceded by an adjective, in an affirmative sentence, or used negatively, as in the preceding examples, should be rendered definite by some additional idea joined to it, as in the following expression:

Have you any more of *Avez-vous encore du bon*
the good bread which *pain* que vous avez
you baked yesterday? *cuit hier*?
I have no more of the *Je n'ai plus du pain ou*
bread, or of the good *du bon pain* que j'ai
bread which I baked *cuit hier*.
yesterday.

The expressions *pain* and *bon pain*, employed affirmatively or negatively, representing no longer the vague and indefinite idea of the substance called *bread* or *good bread*; and their sense being particularized by the additional idea, *which you or I have baked yesterday*; they have become definite, and therefore require to be preceded by the article *the*.

(5.) It happens very often in English, that the partitive words *some* and *any* are used at the end of a sentence, as in the following:

If you have any bread, *Si vous avez du pain,*
give me *some*. *donnez-m'en*.
Have you any cheese? *Avez-vous du fromage?*
No, I have not any. *Non, je n'en ai pas.*

The English expressions, *give me some*, and *I have not any*, are elliptical, and the nouns *pain* and *fromage* are understood after them. The repetition of these nouns would be disagreeable to the ear; but as the sentence ought to be completed in French, this repetition is avoided, and the sense completed by using the personal objective pronouns *it* or *them*, preceded by the partitive preposition *of*; *some* and

any are then omitted, and *of it* and *of them* expressed by the contracted pronoun *en*, placed immediately before the verb in all its tenses, except in the imperative mood, used affirmatively, in which case it follows it; thus, *give me some* is change into *give me of it*, and *I have not any* into *I of it have not*, and rendered as above.

The proper use of the pronoun *en* instead of *some* or *any* is one of the greatest difficulties that beginners have to meet with, and requires a great deal of practice and attention from both pupils and teachers to be attended to properly.

Some few examples will be given now, to illustrate the difficulties attending the use of the partitive sense of nouns. If I say, *Have you helped the lady to some wine? Yes, but she prefers water*: meaning that she always prefers water to wine, there is no partitive idea attached to the noun *water*, and the sentence is rendered by, *Avez-vous offert du vin à Madame? Oui, mais elle préfère l'eau*. But if the above sentence should signify that the lady, although she may be fond of wine, wishes then for some water, the sense of the expression becomes partitive, because the lady wants a part of the water which is there on the table, and the answer should be, *Oui, mais elle préfère de l'eau*.

If I should say to a gentleman, *Will you take tea with me?* I invite that person to sit at the table and partake of the whole meal called tea; he may accept the offer, and not even taste the tea which is on the table; there is then no partitive idea attached to the noun *tea*, and the sentence is expressed by, *Voulez vous prendre le thé avec moi?* But if, while sitting at the table, I ask the gentleman, *Will you take tea or coffee?* I offer him then a part of the tea or coffee which is on the table; the sense becomes partitive, and requires to be expressed by, *Prendrez-vous du thé ou du café?*

We deem what precedes to be sufficient to enable a foreigner to understand fully how to express the partitive meaning of a noun, whether it be definite or indefinite; we should only mention now, that whenever this partitive meaning is to be imparted in French, it ought to be expressed, the partitive preposition *of*, with or without the article, never being

understood, as it is too often the case in English; as in the following:

London and Paris are Paris et Londres sont *de* (some) fine cities. belles villes.

London and Paris are Paris et Londres sont *des* (some) magnificent villes magnifiques.

Why do you lay (some) snares for me? Pourquoi me tendez-vous *des* pièges?

Why do you take (some) snuff? Pourquoi prenez-vous *du* tabac?

When a common noun is composed of a noun and an adjective, these two words form a sense which is indivisible; they are the equivalent to a single word, and consequently ought to be preceded by the article, although employed in a partitive sense; as,

Des petits-maîtres. Des petits-pâtés.
Des petites-maîtresses. Des petits-pois.

But when the noun does not form an indivisible sense with the adjective by which it is preceded, the article is not used with the preposition *of, de*; as,

We become as young children, without pride, malice, and disguise. Nous devenons comme *de* petits enfants, sans orgueil, sans malice, et sans déguisement.

Des petits enfants would be incorrect, because the adjective *petits* and the noun *enfants* do not form an indivisible sense as in *petits pâtés* and *petits pois*.

Remarks. Some writers have used the article before nouns used in a partitive sense and preceded by an adjective, when they do not form an inseparable sense; as in,

The other day he was asking questions of little children. L'autre jour il interrogeait *des* petits enfants.

They drive before them asses and small horses. Ils chassent devant eux *des* ânes, et *des* petits chevaux.

We wish to meet with honest men, because their society is the only one which pleases us. Nous voulons trouver *des* honnêtes gens, parceque leur société est la seule qui nous plaise.

In these cases the adjective and the noun are considered as forming a compound expression, having the character of a noun.

The partitive sense should not be mistaken for the general sense, for in this latter case the article must be used; as,

It is the opinion of ancient philosophers. C'est l'opinion *des* anciens philosophes.

This expression, *des anciens philosophes*, is not partitive, but signifies a whole.



"Thou hast thy beauties: sterner ones I own,
Than those of thy precursors; yet to thee
Belong the charms of solemn majesty
And naked grandeur. Awful is the tone
Of thy tempestuous nights, when clouds are
blown

By hurrying winds across the troubled sky;
Pensive when softer breezes faintly sigh
Through leafless boughs, with ivy overgrown.
Thou hast thy decorations too: although
Thou art austere; thy studded mantle, gay
With icy brilliants, which as proudly glow
As erst Goleouda's, and thy pure array
Of regal ermine, when the drifted snow
Envelopes Nature, till her features seem
Like pale, but lovely ones, seen when we
dream."

BARTON.

It is February. Yes! one-twelfth of the present year is gone, and we have already entered upon another month, perhaps not so cheering with vivid associations and festive meetings, as that which has just passed, but one that although called "dreary and chilly," is, nevertheless, replete with happiness and pleasant remembrances.

It is pretty generally known that Numa Pompilius altered the Roman calendar, by adding two months (January and February) to the year, and, also, that he

assigned twenty-nine days to the latter. Julius Cæsar did not make any alteration in the calendar of Numa, but Augustus Cæsar subtracted one day from February and added it to his *own* month of August. Every fourth year an additional or twenty-ninth day was *intercalated* between the twenty-third and twenty-fourth of this month, and was unnoticed; but now the intercalated day occurs every fourth or *leap* year, and is placed after the twenty-eighth; it is, therefore, the 29th or last day of February.*

Antiquarians and historians have never satisfactorily settled the etymology of this month, and as we cannot hope to arrange that which has so long been the subject of warm discussion, we shall merely pass in review the various opinions advanced, and leave our readers to select the one they prefer.

The name of the month is said by some to be derived from *Februa*, one of the names of the goddess Juno, who presided over the feasts of purification held in this month. It is also said to have been named by Numa Pompilius either from the fevers that prevailed in Italy at the time he altered the calendar of Romulus, or else from *Februo*, to purify, because the people held an expiatory sacrifice for the sins they had committed during the past year, as this was originally held to be the last month of the year. Numa Pompilius placed this month under the especial protection of Neptune, who governed one of the four elements—water.

The Romans held certain feasts during the month, viz., the *Feralia*, *Charistia*, *Lupercalia*, and *Terminalia*. The first of these was held upon the 11th; the second upon the 12th; the third upon the 15th; and the last upon the 22nd or 23rd of the month; but as our purpose is not to describe the superstitious rites of these festivals, we will pass on to the consideration of more important matters.

The usual allegorical representation of the month, is a young man dressed in a dark or cloudy sky-coloured habit, symbolical of the frequent rain and gloomy

sky. On his left is the astronomical sign of *Pisces* or the fishes, to intimate that the sun enters that sign on the 19th of the month. February has been represented as a young man dressed in a white robe, with a wreath of snowdrops round his brows, and a burning candle in his right hand. Our Saxon ancestors painted this month as a vine-dresser pruning his trees; and, sometimes, as a man in a frieze-jacket buttoned close up to the throat, throwing his arms across his body, the same as we frequently observe cabmen and others at this time of the year when the weather is very inclement.

The Saxons called this month *Sprout Kale*,* or the month in which young coleworts or cabbages begin to sprout; but it was afterwards called *Sol Monath*, or sun month, because the sun returns and warns us of the approach of spring, with its fresh vegetation and balmy airs. In Latin, it is called *Februarius*; in French, *Février*; in Italian, *Febrajo*; and in Portuguese, *Fevereiro*.

The red letter days of February, or its feasts, fasts, and festivals, are tolerably numerous and remarkable. In addition, we have days rendered memorable by certain events chronicled by the antiquary and historian with due care; some of these we shall advert to in our review of the month.

THE FIRST DAY of this month is always remembered by sportsmen as the end

* Verstegan informs us that, by *kele*, the Saxons meant *cole-wort*, or *kele-wurt*; "which," says he, "was the greatest *pot-wurt* in time long past, that our ancestors used, and the *broth* made thereof was called *kele* or *kale*." Before we borrowed from the French the words *pottage* and *herb*, the first, in our own language was termed *kele*, and the second, *wurt*; and as this *kele-wurt*, or pottage-herb, was the chief *winter-wurt*, or garden vegetable of the husbandman, so also it was the first herb which in this month began to yield wholesome young sprouts. "This herb," says Verstegan, "was held, not only by our ancestors, to be very good both for sustenance and health; but the ancient Romans had also such an opinion thereof, that during six hundred years, whilst Rome was without physicians, the people were accustomed to plant great stores of these *wurts*, which they accounted both meat and medicine; for, as they did eat the wurt for sustenance, so did they drink the water wherein it was boiled, as a thing sovereign in all kinds of sickness." Throughout Scotland this mode of using *cole-wort*, or *kail*, is continued to the present day, and there are few poor cottagers that do not cultivate a *kail-yard*.

* A very simple way to find out when leap-year will come again, is to divide the year by 4 | 1853
four, thus: $\frac{463+1}{4}$ It is therefore clear that leap-year will not occur again until 1856.

of pheasant and partridge-shooting; a happy time for part of the feathered tribe!

It was on this day in 1394, that Charles VI., King of France, was nearly burnt to death at a masquerade given in honour of one of the Queen's ladies, in consequence of the Duke of Orleans applying a lighted flambeau to the dress of one of the King's companions, which, being made of flax, instantly burst into a blaze, and communicating with the furniture of the room and the other persons with the King, caused a general conflagration, and the death of four of his majesty's companions.

We must also remember that the death-warrant of Mary, Queen of Scots, was signed upon this day in 1587, by Queen Elizabeth, of England. Nor can we forget that poor Frederick Augustus I., King of Poland, who was driven from his throne by Charles XII. of Sweden, and restored after the defeat of Charles at Pultowa, died upon this day at Warsaw, at the age of sixty-three, universally beloved by the Saxons and Poles. In 1737, King George II., instituted the first military office of field-marshal of the British army.

THE SECOND DAY is called CANDLEMAS-DAY, or the PURIFICATION of THE VIRGIN MARY, alluding to the declaration of Simeon concerning our Saviour, that he should be "a light to lighten the Gentiles." Its name of Candlemas-day no doubt arose from the circumstance that the festival was celebrated in this, and is now in Roman Catholic countries, by torchlight processions, and the performance of *mass* with a multitude of *candles* in the several churches. These customs are said to have been derived from the Romans, who went about their city with lighted torches on this day, in honour of *Februa*, and to have been introduced into the church of Rome by Pope Sergius. Such practices were continued in England, until the second year of the reign of Edward VI., when Archbishop Cranmer suppressed them, by order of the King's Privy Council.

Anciently, this day was called that of Christ's Presentation; and in the Reformed Church, it is still kept as a solemn festival, in memory of the humiliation of the Virgin Mary, who presented the infant Jesus in the Temple; for, to render

the first-born son holy unto the Lord, it was enjoined by the Mosaical ordinances, that attendance should be given in the Temple, and that an offering should at the same time be made of money, or sacrifice. The Virgin Mary, therefore, attended with her first-born on the appointed day, and presented a pair of doves, as an offering suitable to her circumstances. From this pious obedience to the law, on the part of the mother of our Lord, arose the rite of *churching women* after childbirth, in this country; but as the ancient Mosaical institution has been abrogated by the new and more perfect law, no other sacrifice than that of the heart is now enjoined: nor is any precise day fixed for the public performance of this act.

In 1300, upon this day, Pope Boniface VIII. instituted the Jubilees in the Romish Church. In 1461, Edward, Earl of March, defeated the forces of Henry VI., under the command of the Earl of Pembroke, at Mortimer's Cross, near Ludlow, and Owen Tudor, prince of Wales, was beheaded on the spot. In 1625, Charles I., was crowned in Westminster Abbey, with his Queen Henrietta Maria, by Abbot, Archbishop of Canterbury.

On this day, in 1845, Christopher Wordsworth, D.D., the celebrated poet, died, leaving the British nation his beautiful compositions as a memento. The many varied and beautiful poems he composed, rank foremost among the best productions of modern poets, and we are sure that our practical readers will pardon us, for introducing some selections from them:

EXERCISE.

Rise with the lark! your matins shall obtain
Grace, be their composition what it may,
If but with hers performed: climb once again,
Climb every day, those ramparts; meet the
breeze
Upon their tops; adventurous as a bee
That from your garden thither soars to feed
On new-blown heath; let yon commanding rock
Be your frequented watch-tower; roll the stone
In thunder down the mountains: with all your
might
Chase the wild goat; and, if the bold red deer
Fly to these harbours, driven by hound and horn
Loud echoing, add your speed to the pursuit:
So, wearied to your hut shall you return,
And sink at evening into sound repose.

THE THIRD DAY is dedicated to *St. Blaise* a bishop of Sebaste, in Armenia, who suffered martyrdom under Dioclesian,

in the year 289. He is said to have found out the art of *combing-wool*, on which account, the journeymen wool-combers in England have sometimes a grand procession on this day. One of the trade personates the bishop, carrying a pair of combs in his hands. In Leeds, Norwich, and other places, where the wool-combers are numerous, this procession excites much interest.

In 1738, Sir Thomas Lombe, the proprietor of the first and largest silk-mill ever constructed in England for throwing, died. He received £14,000 from Parliament for having contributed materially to the national prosperity, and the model of the machine was deposited in the Tower of London. In 1807, Monte Video, on the river Plata, was taken by assault by the British forces, under the command of Brigadier-General Auchmuty.

THE FOURTH DAY.—In 838, Egbert, the first sole monarch of England, died. He was the 17th king of the West Saxons. Having conquered Kent, he laid the foundation of the sole monarchy of England, in 823, being crowned at Winchester, where he was afterwards interred. This king issued an edict in 827, commanding that all the south of Britain should in future be called England.

In 1194, Richard I., King of England, was released from his confinement in the castle of Olmutz, in Moravia, where he was imprisoned, while passing through Germany on his return from the Crusade against the Saracens in the Holy Land. The ransom price was fixed at 160,000 marks (£106,666 13s. 4d.), a sum so enormous in that age, that the clergy were obliged to sell the church plate to raise the money. In 1536, the famous Act for abolishing everything relating to the Pope's supremacy, was passed by the British Parliament.

In 1554, Rogers, the divine, was burnt at the stake in Smithfield; being the first Protestant martyr in the reign of Queen Mary. He assisted Tindall to translate the New Testament.

In 1615, died Jean Baptiste Porta, a learned Neapolitan gentleman, who was the first person to project an Encyclopædia, and was the inventor of the Camera Obscura.

In 1812 the Rev. Robert Blair, author

of the celebrated poem of the "Grave," died in the forty-seventh year of his age.

THE FIFTH DAY is dedicated to *St. Agatha*, a female martyr put to death by order of Decius, in 251. The cities of Palermo and Catania dispute the honour of her birth, and her memory is religiously cherished, and superstitiously celebrated in Sicily.

A. D. 5. The Emperor Augustus is said to have had the title of "*Pater Patriæ*," or Father of the Country, conferred upon him by the Roman Senate,—a distinction which he received with tears.

In 1781, Lord George Gordon was tried, before the Earl of Mansfield, for exciting the riots of 1780, and acquitted; after this he published a libel against the Queen of France, in 1786, and was obliged to escape to Holland, in consequence; however, he afterwards returned to England disguised as a Jew, which persuasion he had adopted, and being committed to Newgate, died there in 1793.

In 1783, the town of Scylla, in the south-west corner of Calabria, was destroyed by an earthquake, and 3,000 people perished in consequence. In the same year his majesty George III. instituted the most illustrious order of knighthood for Ireland, the knights of St. Patrick, the King to be sovereign, the governor-general of Ireland, grand-master, and sixteen knights companions. This order has a king-at-arms called Ulster, and a chancellor, register, secretary, and usher.

In 1788, Sir Robert Peel, the illustrious statesman, was born.

In 1799, Luigi Galvani, the discoverer of galvanism, died at Bologna, in Italy.

In 1810, the British forces, under the command of General Beckwith, captured Guadaloupe.

THE SIXTH DAY is celebrated as that upon which King Charles II. died at Whitehall, in 1685, in the 59th year of his age, being succeeded by his brother the Duke of York, afterwards James II.

In 1806, Admiral Duckworth captured and destroyed the French fleet off St. Domingo, in the West Indies.

THE SEVENTH DAY.—In 1689, the Peers and Commons of England met at Whitehall, under the name of the Convention, and declared the throne vacant, by the abdication of King James II.

In 1788, Governor Philip assumed the title and authority of captain general and governor of New South Wales, and the royal commission was published announcing this, at Sydney Cove, about nine miles from Botany Bay.

THE EIGHTH DAY. In 1587, *Mary, Queen of Scots*, was beheaded in the 43rd year of her age, by order of Elizabeth, Queen of England, her cousin; at Fotheringay Castle, in Northamptonshire, after a cruel imprisonment of nineteen years. She was afterwards buried in Peterborough Cathedral; but on the accession of her son, James VI. of Scotland, to the English throne, her remains were removed to Westminster Abbey.

In 1671 Richard Pendrell, the guide and preserver of Charles II. after his escape from the battle of Worcester, died and was buried in St. Giles's church-yard, London.

THE NINTH DAY of the month, this year, is *Ash-Wednesday, the first day of Lent*, which was so called, from a custom among the Christians of the ancient church, of penitents expressing humiliation for their sins, by appearing in the church, in *sackcloth and ashes*, and having ashes sprinkled on their heads when admitted to do penance, "to put in remembrance every Christian man, the begining of Lent and penance, and that he is but ashes and earth, and thereunto shall return." For such discipline is now substituted the public reading of the curses denounced against impenitent sinners, the people saying "Amen" after each malediction. The word LENT, in the ancient Saxon language, is called *Lengten*, which signifies *Spring*; therefore this was denominated the Spring Fast, or *Lengten Fast*, that is, the time of humiliation and prayer, observed by Christians before EASTER. At what period *forty days* were appointed for this solemn fast is unknown; but it seems probable that those who fixed that space of time, had respect for the forty days' fast of our Saviour in the wilderness.

In 1555, Hooper, Bishop of Gloucester was burnt before the door of his own cathedral, during the persecution of the sanguinary Queen Mary. He suffered with the greatest firmness, in confirmation of his attachment to the Protestant cause. On the same day, Dr. Rowland

Taylor was burnt at Hadleigh, in Suffolk, testifying the sincerity of his faith by his undaunted behaviour at the stake.

In 1811, Dr. Maskelyne, (who held the appointment of astronomer royal for forty-six years), died at Flamstead House, Greenwich Park, near London.

THE TENTH DAY, in 1660, was the insurrection of the Fifth Monarchy Men, a set of religious fanatics, headed by a wine-cooper, named Venner, who was arrested the 19th, and the commotion suppressed. The ringleaders were executed in various places, as a warning to others.

In 1840 our most Gracious Sovereign, Queen Victoria was united to Prince Albert.

THE ELEVENTH DAY. In 1418, Sir John Oldcastle, Baron Cobham, an adherent of Wicliff, was burnt or rather *roasted alive*, in St. Giles's Fields.

In 1503, Elizabeth of York, daughter of Edward IV., whom Henry VII. had espoused in order to establish himself more firmly on the throne, by uniting the White and Red Roses of York and Lancaster, died in childbed, and soon afterwards the princess to whom she had given birth.

In 1650, René Descartes, the mathematician, died in Sweden; his body being afterwards carried to Paris, and interred with great pomp.

In 1662, London Bridge was burnt, and many persons perished in the conflagration.

In 1821, Adam Walker, the celebrated lecturer upon experimental philosophy, and author of many philosophical works, died at Richmond, in Surrey. He was the inventor of the "*Eidouranion*," or "*Transparent Orrery*," the warm-air stove, and "*Celestina*."

In 1847, M. Napier, the celebrated editor of the "*Edinburgh Review*," died at the age of 70.

THE TWELFTH DAY. In 1447, Humphrey, Duke of Gloucester, was murdered at St. Alban's; and Lady Jane Grey beheaded in 1554, in the Tower of London, about an hour after her husband, Lord Guildford Dudley, the fourth son of the Duke of Northumberland.

In 1754, Prince Talleyrand was born; in 1804, Emmanuel Kant, the celebrated German Philosopher, died; and in 1837, the famous chemist, Edward Turner, died.

THE THIRTEENTH DAY. In 1542, Catherine Howard, fifth Queen of Henry VIII., was beheaded on Tower-hill.

In 1689, William and Mary were proclaimed King and Queen of Great Britain. In the history of England, the accession of the Protestant King William to the throne is styled the *Glorious Revolution*.

In 1847, the celebrated Sharon Turner, author of "The Sacred History of the World," "History of the Anglo-Saxons," &c., died at the age of 78.

THE FOURTEENTH DAY, is dedicated to *St. Valentine*, and is the *Old Candlemas Day*. *St. Valentine* was an ancient presbyter of the Church at Rome, and was beheaded in the *Via Flaminia*, about the year 278, during the reign of the Emperor Valerianus. At Rome, patron saints are chosen upon this day. "St. Valentine's day is supposed to have been substituted by the Church, for the pagan Lupercalia, in the course of which the names of young women used to be enclosed in a box, and drawn for by their future partners, in accordance with which practice, on this festival, valentines were chosen by throwing the names of an equal number of males and females into two heaps, after which a general drawing took place on both sides; when the whole party had been thus paired by chance, the men gave balls and treats to their mistresses, wearing their billets for several days on their breasts or sleeves. On this day, the gallants sent presents of gloves, silk stockings, garters, or jewellery to their valentines. Another mode was to look out of the door or window early in the morning, and the person first seen, if unmarried, was considered to be the destined individual." The practice of looking out of the window or door is mentioned in "Hamlet," where Ophelia sings:

"Good morrow! 'tis St. Valentine's day,
All in the morning betime,
And I a maid at your window,
To be your Valentine."

The practice of making presents is still kept up in many parts of England, particularly in Devonshire; where a young woman thus addresses the first young man she meets:

"Good morrow, Valentine, I go to-day,
To wear for you what you must pay,
A pair of gloves next Easter-day."

In 1400, Richard II., King of England, was basely murdered in Pontefract Castle, Yorkshire, where he was imprisoned. His strength and courage were so great, that he slew four of the eight assassins who attacked him.

In 1776, Captain James Cook, the famous circumnavigator, was killed in a skirmish with the savages of Owhyhee, one of the Sandwich Islands, in the Pacific Ocean.

In 1780, Sir William Blackstone, author of the celebrated "Commentaries on the Laws of England," died.

In 1797, Sir John Jervis, afterwards Earl St. Vincent, obtained a signal victory over the Spanish fleet, off Cape St. Vincent, in Portugal.

THE FIFTEENTH DAY. In 1564, Galileo Galilei, was born at Pisa, of a noble Florentine family. He improved the telescope in 1609, constructed microscopes in 1612, and discovered Jupiter's Satelites in 1614, and seems to have been the first to notice the points of rest and motion in the sounding-board of a musical instrument.

In 1695, on this day, King William III. was to have been assassinated by conspirators, on his return from Richmond to London, but the plot was defeated by the conveyance of timely notice to His Majesty and Ministers.

In 1732, Francis Atterbury, Bishop of Rochester, a celebrated poet and political writer, died in exile at Paris, having been banished from England for corresponding with the exiled royal race of Stuart. His body was brought to England, and interred in Westminster Abbey.

In 1810, the Dutch islands of *Saint Eustatia*, *Saint Martin*, and *Saint Saba*, were surrendered to the British.

In 1840, the illustrious surgeon, Sir Astley Cooper died, at the age of 73.

THE SIXTEENTH DAY. In 1497, the celebrated divine, Philip Melancthon, the coadjutor of Martin Luther in the great work of the Reformation of the Christian Church, was born in the small town of Brethen or Bretheim, in the Palatinate of the Rhine. He was appointed by the general body of the Reformers, in the early part of 1530, to draw up the exposition of their opinions, which was presented to the Emperor at Augsburg,

in March of the same year; and is well known as the "Confession of Augsburg."

In 1754, Dr. Richard Mead, the celebrated London physician, died. He made the experiment, in 1721, of inoculating for the small-pox: and was very successful, having first operated upon seven condemned criminals in Newgate.

THE SEVENTEENTH DAY. In 1461, the second battle of St. Alban's was fought, wherein upwards of 2,000 Yorkists perished, and Queen Margaret defeated the forces of the Earl of Warwick, and set her husband free from captivity.

In 1653, Michael Buonarrotti Angelo, the father of epic painting, and also celebrated for his architectural triumphs and beautiful pieces of sculpture, died at Rome, having nearly completed his 89th year.

THE EIGHTEENTH DAY. In 1478, the Duke of Clarence, brother to King Edward IV., was drowned in a butt of Malmsey wine; and in 1546, the great reformer, Martin Luther, died at Eisleben, in the 63rd year of his age.

THE NINETEENTH DAY. In 1437, King James I. of Scotland was murdered; and in 1849, B. Barton, the Quaker poet, died, at the age of 69. Our poetical readers, no doubt, remember his beautiful compositions, particularly those upon "Human Life;" "The Stars;" "The Falling Leaf;" "The Sea;" "The Sun."

THE TWENTIETH DAY. In 1547, Edward VI. was crowned King of England, at Westminster, when he created forty knights of the Bath.

THE TWENTY-FIRST DAY. In 1437, King James I. of Scotland, was treacherously murdered at Perth, while taking supper in the convent of the Dominican Friars; and his wife Joan received two wounds while trying to prevent his assassination. In 1838, the celebrated oriental scholar, Silvestre de Lacy, died at the age of 80; and in 1845 the Rev. S. Smith, author of the "Plymley Letters," &c., at the age of 74.

THE TWENTY-SECOND DAY. In 1806, the celebrated painter, James Barry, died in his 65th year; and in 1824, John Davy, the composer of "The Bay of Biscay," "May we ne'er want a Friend," &c. died in great distress, and almost without a friend.

THE TWENTY-THIRD DAY. In 1792,

the eminent painter, Sir Joshua Reynolds, died at his house in Leicester-fields, and was afterwards buried in St. Paul's Cathedral, where a monument is erected to his memory.

THE TWENTY-FOURTH DAY is dedicated to *St. Matthias*, who was one of the seventy-two disciples of Christ, and a most faithful and constant attendant upon his Divine Master, until his ascension; after which he was elected to fill the place of the traitor Judas Iscariot; and having preached the Gospel in various parts, particularly in Cappadocia, and along the shores of the Caspian Sea, was executed at Colchis. The manner of his death is not certain; some asserting that he was crucified, while others maintain that he was beheaded. On this day, in 616, Ethelbert, 5th King of Kent, and 6th monarch of Britain, died; and in 1308, King Edward II. and his queen Isabella, were crowned at Westminster.

THE TWENTY-FIFTH DAY. In 1601, Queen Elizabeth's favourite, the Earl of Essex, was beheaded privately in the Tower of London, in his 34th year, for trying to incite the people against the queen; and in 1723, the famous architect, Sir Christopher Wren, died in his 91st year, and was afterwards buried in the vaults of St. Paul's, one of the great triumphs of his art.

THE TWENTY-SIXTH DAY. In 1797, the Bank of England suspended cash payments (by an order of Council), in consequence of the great demand of specie, particularly gold, for foreign payments; and from persons hoarding their gold. A guinea was then valued at 27 shillings.

THE TWENTY-SEVENTH DAY. In 1706, John Evelyn, the author of "Sylva, or a Discourse of Forest Trees," and many other works, died at the age of 85, at Wotton in Surrey. He was distinguished as a natural philosopher. In 1814, the illustrious Duke of Wellington defeated Marshal Soult, at the battle of Orthez, near Bayonne, France.

THE TWENTY-EIGHTH DAY. In 1582, the eminent Scottish poet and historian, George Buchanan, died. In 1674, peace was ratified with Holland, by which the English obtained many advantages.

The natural history of February is not so rich with materials for study and

thought as other months, but yet we have variety, and ample matter for reflection.

The flowers of the month are the snow-drop (*Galanthus nivalis*), with its elegant drooping corolla. The golden crocus, (*Crocus vernus*) harbinger of Spring; parti-coloured crocus (*Crocus versicolor*), and the Scotch crocus (*Crocus biflorus*). Then we have the red dead-nettle, (*Lamium purpureum*), seen on most sheltered hedge-banks during the month, with the common groundsel (*Senecio vulgaris*), the delight of our feathered songsters: for who has not seen,

“The little goldfinch pluck
The groundsel's feather'd seeds, and twit, and
twit.”

The mezereon (*Daphne mezereon*), and Pontic Daphne (*Daphne pontica*), delight the eye amid the heap of almost forlorn-looking shrubs that abound during this month, but occasionally we may notice in some well cultivated grounds the Japan quince (*Cydonia Japonica*), with its scarlet flowers.

The dandelion (*Leontodon taraxacum*), the root of which is used by physicians, either in the form of decoction or extract, and the leaves for salad by many persons, is seen during this month in the meadows, and we may also observe in our walks abroad the common violets (*Viola odorata*); the fringed star of Bethlehem (*Ornithogalum frimbriatum*); the Watson's corn-flag, (*Gladiolus Watsonius*); several varieties of hepatica, particularly the *Hepatica triloba*; the wild primrose (*Primula vulgaris*); the coltsfoot (*Tussilago farfara*); the marsh marigold (*Caltha palustris*); the Coan sow-bread (*Cyclamen Coum*); the Siberian squill (*Scilla Sibirica*); the two-leaved squill (*Scilla bifolia*); the spring bulbocodium (*Bulbocodium vernalis*); and the bean-leaved species (*Corydalis fabacea*). We may frequently see the herbaceous heath (*Erica cinerea*); the Canadian flea-bane (*Erigeron Canadensis*); the Daturian rose-laurel (*Rhododendron Daturicum*); and the Lapland diapensia (*Diapensia Lapponica*); with the Chimonanthus (*Chimonanthus fragrans*); and *Chimonanthus grandiflorus*.

The principal birds that are seen at this season, are the tomtit (*Parus cæruleus*); the house-sparrow (*Passer domesticus*); the golden-crested wren (*Regulus*

cristatus); the sky-lark (*Alauda arvensis*); the common wren (*Anorthura communis*); the yellow-hammer (*Emberiza citrinella*); the chaffinch (*Fringilla spiza*); and the rook (*Corvus predatorius*). There are other birds which are regarded in a different light to those we have mentioned, such, for example, as the curlew (*Numenius arquata*); the golden-plover (*Charadrius plumialis*); the Brent goose (*Anser brenta*); and the Bernacle goose (*Anser bernicla*); and the wild goose (*Anser palustris*). Then we have the partridge (*Perdix cinerea*), which is decidedly a bird of the month, because they begin to pair and look out for proper nesting-places during the month, and so does the tawny owl (*Strix aluco*); the kingfisher (*Alcedo ispida*); and the tame goose (*Anser palustris domes.*)

The fish of the month are the grayling (*Coregonus Thymallus*); the salmon (*Salmo salar*), which descends the rivers to the sea; and the dace (*Leuciscus communis*), which is unfit to eat as it spawns.

The chief insects of the month are the dark carrion-beetle (*Silpha opaca*); the bacon-beetle (*Dermestes lardarius*); the ditch-beetle (*Hydrophilus caraboides*); the lurid pool-beetle (*Berosus luridus*); and the mealworm beetle (*Tenebrio molitor*). The moths which are chiefly seen during the month are the February carpet-moth (*Aplocera cæsiata*); the spring-usher moth (*Anisopteryx leucopheria*); the dark-bordered usher (*Anisopteryx Nigricaria*); the small egger moth (*Eriogaster lanestris*); the orange upper-wing moth (*Xanthia croceago*); the clouded lead moth (*Diurnea tortricella*); the clouded brown moth (*Capillaria tesserella*); the small brindled beauty moth (*Nyssia hispidaria*); the rosy day moth (*Diurnea salicella*); and the brimstone butterfly (*Gonepteryx rhamni*). The slow-worm (*Anguis fragilis*), also shows itself during the month.

The quadrupeds of the month are virtually the mole (*Talpa Europæa*); the sheep (*Ovis aries*); and the bats (*Vespertilio murinus*, &c.), but there are many others that are not regarded as pertaining to the chilly month of February. The wintry garb still clothes shivering Nature, but the gradual lengthening of the days is a harbinger of Spring, and bids us look forward with cheerful anticipation to the period of reviving vegetation.

NATURAL PHILOSOPHY.

SPECIFIC GRAVITY:—*continued from page 98.*

For the determination of the densities of liquids there is still another method, often more convenient than the former, and very commonly resorted to; it is by the aid of instruments which pass under the name of Hydrometers or Aërometers.

The principle on which these act is, that when a body floats upon water, the quantity of fluid displaced is equal *in volume* to the volume of the part of the body immersed, and *in weight* to the weight of the whole body.

Thus, a piece of cork floating on the surface of quicksilver, water, and alcohol, sinks in them to very different depths: in the quicksilver but little, in the water more, and in the alcohol still deeper; but in every instance the weight of the quantity of the liquid displaced is equal to that of the cork.

It is plain, therefore, that to determine the specific gravity of a liquid, we have only to determine the depth to which a floating body will be immersed in it. The hydrometer fulfils these conditions. It consists of a cylindrical cavity of glass, A. Fig. 56, on the lower part of which a spherical bulb, B, is blown, the latter being filled with a suitable quantity of small shot or quicksilver. From the cylindrical portion, A, a tube, C, rises, in the interior of which is a paper scale bearing the divisions. The whole weight of the instrument is such that it floats in the liquid to be tried, and if that liquid is to be compared with water, and is lighter than water, the zero of the divided scale is toward the lower end of the paper; but if the liquid be heavier than water, the zero is toward the top of the scale. Tables are usually constructed, so that, by their aid, when the point at which the hydrometer floats in a given liquid is determined in any experiment, the specific gravity is expressed opposite that number in the table.



Fig. 56.

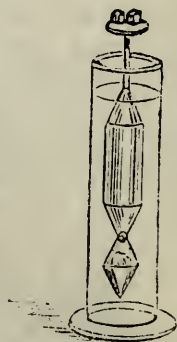


Fig. 57.

Of these scale-hydrometers we have several different kinds, according as they are to determine different liquids. Among them may be mentioned Beaumé's hydrometer, an instrument of constant use in chemistry. In the finer kinds of aërometers the weighted sphere, B, Fig. 56, forms the bulb of a delicate thermometer, the stem of which rises into the cavity, A. This enables us to determine the temperature of the liquid at the same time with its specific gravity.

Nicholson's gravimeter is a hydrometer which enables us to determine the density either of solids or liquids. It is represented by Fig. 57.

CHAPTER XII.

HYDROSTATIC PRESSURES AND FORMATION OF FOUNTAINS.

Fundamental Fact of Hydrostatics—holds also for Gases.—Illustrations of Upward Pressure.—Determination of Specific Gravities of Liquids on these Principles.—Theory of Fountains.—Cause of Natural Springs.—Artesian Wells.

THE fundamental fact in hydrostatics thus appears to be, that as each atom of a liquid

yields to the influence of gravity without being restrained by any cohesive force, all the particles of such a mass must press upon those which are immediately beneath them, and therefore the pressure of a liquid must be as its depth.

The same fact has already been recognized for elastic fluids, in speaking of the mechanical properties of the earth's atmosphere, which, for this very reason, and also from the circumstance that it is a highly compressible body, possesses different densities at different heights. The lower regions have to sustain or bear up the weight of all above them; but as we go higher and higher this weight becomes less and less, until at the surface it ceases to exist at all.

We have already shown, from the nature of a fluid, such pressures are propagated equally in all directions, upward and laterally, as well as downward. This important principle deserves, however, a still further illustration from the consequences we have now to draw from it. Let a tube of glass, *a b*, Fig. 58, have its lower end, *b*, closed with a valve slightly weighted and opening upward, the end, *a*, being open. On holding the tube in a vertical position, the valve is kept shut by its own weight. But if we depress it in a vessel of water, as soon as a certain depth is reached the upward pressure of the water forces the valve, and the tube begins to fill. Still further, if before immersing the tube we fill it to the height of a few inches with water, we shall find that it must now be depressed to a greater depth than before, because the downward pressure of the included water tends to keep the valve shut.



Fig. 58.

From the same principles it follows, that whenever a liquid has freedom of motion, it will tend to arrange itself so that all parts of its surface shall be equi-distant from the centre of the earth. For this reason the surface of water in basins and other reservoirs of limited extent is always in a horizontal plane; but when those surfaces are of greater extent, as in the case of lakes and the sea, they necessarily exhibit a rounded form, conforming to the figure of the earth. It is also to be remembered that, when liquids are included in narrow tubes, the phenomena of capillary attraction disturb both their level and surface-figure.

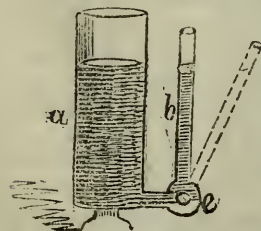


Fig. 59.

All liquids, therefore, tend to find their own level. This fact is well illustrated by the instrument, Fig. 59, consisting of a cylinder of glass, *a*, connected by means of a horizontal branch with the tube, *b*, which moves at a tight joint at, *c*. By this joint, *b* can be set parallel to *a*, or in any other position. If *a* is filled with water to a given height, the liquid immediately flows through the horizontal connecting-pipe, and rises to the same height in *b* that it occupies in *a*. Nor does it matter whether *b* be parallel to *a*, or set at any inclined position; the liquid spontaneously adjusts itself to an equal altitude.

The same liquid always occupies the same level. But when in the branches of a tube we have liquids, the specific gravities of which are different, then, as has already been stated in Chapter X., they rise to different heights. The law which determines this is, "*The heights of different fluids are inversely as their specific gravities.*" If, therefore, in one of the branches of a tube, *a b*, Fig. 60, some quicksilver is poured so as to rise to a height of one inch, it will require in the other tube, *b c*, a column of water $13\frac{1}{2}$ inches long to equilibrate it, because the specific gravities of quicksilver and water are as $13\frac{1}{2}$ to 1.

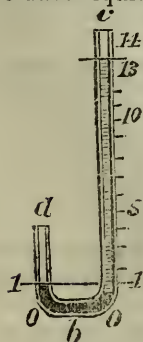


Fig. 60.

A very neat instrument for illustrating these facts is shown in Fig. 61. It consists of two long glass tubes, *a b*, which are connected with a small exhausting syringe, *c*, their lower ends being open dip into the cups, *w a*, in which the liquids whose specific gravities are to be tried are placed. Let us suppose they are water and alcohol. The syringe produces the same degree of partial exhaustion in both the tubes, and the two liquids, equally pressed up by the atmospheric air, begin to

rise. But it will be found that the alcohol rises much higher than the water—to a height which is inversely proportional to its specific gravity.

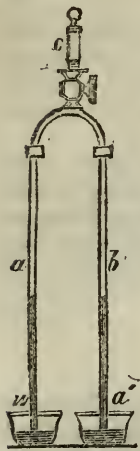


Fig. 61.

When in the instrument, Fig. 59, we bend the tube, *b*, upon its joint, so that its end is below the water-level in *a*, the liquid now begins to spurt out: or if, instead of the jointed tube, we have a shorter tube, *C e D*, Fig. 62, proceeding from the reservoir, *A B*, the water spouts from its termination and forms a fountain, *E F*, which rises nearly to the same height as the water-level. The resistance of the air and the descent of the falling drops shorten the altitude, to which the jet rises to a certain extent. On the top of the fountain a cork ball, *G*, may be suspended by the playing water.

The same instrument may be used to show the equality of the vertical and lateral pressures at any point. For let the tube, *D E*, be removed so as to leave a circular aperture at *e*; also let *C* be a plug closing an aperture in the bottom of exactly the same size as *e*. Now, if the reservoir, *A B*, be filled to the height *g*, and kept at that point by continually pouring in water, and the quantities of liquid flowing out through the lateral aperture, *e*, and

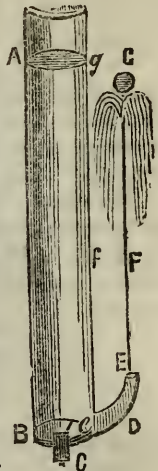


Fig. 62.

the vertical one, *C*, be measured, they will be found precisely the same, showing, therefore, the equality of the pressures; but if an aperture of the same size were made at *f*, the quantity would be found correspondingly less.

It is upon these principles that fountains often depend. The water in a reservoir at a distance is brought by pipes to the jet of the fountain, and there suffered to escape.

The vertical height to which it can be thrown is as the height of the reservoir, and by having several jets variously arranged in respect of one another, the fountain can be made to give rise to different fanciful forms, as is the case with many public fountains.

A simple method of exhibiting the fountain is shown in Fig. 63. A jar, *G*, is filled with water, and a tube, bent as at *a b c*, is dipped in it. By sucking with the mouth at *a*, the water may be made to fill the tube, and then, on being left to itself, will play as a fountain.



Fig. 63.

On similar principles we account for the occurrence of springs, natural fountains, and Artesian wells. The strata composing the crust of the earth are, in most cases, in positions inclined to the horizon. They also differ very greatly from one another in permeability to water—sandy and loamy strata readily allowing it to percolate through them while its passage is more perfectly resisted by tenacious clays. On the side of a hill, the superficial strata of which are pervious, but which

rest on an impervious bed below, the rain water penetrates, and being guided along the inclination, bursts out on the sides of the hill or in the valley below, wherever there is a weak place or where its vertical pressure has become sufficiently powerful to force a way. This constitutes a common spring.

The general principle of the Artesian or overflowing wells is illustrated in Fig. 64.

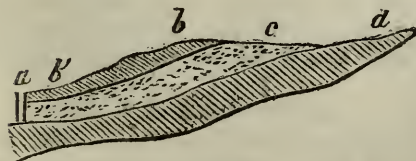


Fig. 64.

Let *b' b c d*, be the surface of a region of country the strata of which, *b' b* and *d*, are more or less impervious to water, while the intermediate one, *c*, of a sandy or porous constitution, allows it a freer passage. When in the distant sandy country at *c*, the rain falls, it percolates readily and is guided by the resisting stratum, *d*. Now if at *a*, a boring is made deep enough to strike into *c* or near to *d* on the principles which we have been explaining, the water will tend to rise in that boring

to its proper hydrostatic level, and therefore, in many instances, will overflow at its mouth. The region of country in which this water originally fell may have been many miles distant.

["London stands in a hollow, of which the first or innermost layer is a basin of clay, placed over chalk, and on boring through the clay (sometimes of 300 feet in thickness) the water issues, and in many places rises considerably above the surface of the ground, showing that there is a higher source or level somewhere."—*Dr. Arnott's "Elements of Physics," 3rd ed., p. 275.*]

It follows, from the action of gravity on liquids, that if we have several which differ in specific gravity in the same vessel, they will arrange themselves according to their densities. Thus, if into a deep jar we pour quicksilver, solution of sulphate of copper, water, and alcohol, they will arrange themselves in the order in which they have been named.

CHAPTER XIII.

OF FLOWING LIQUIDS AND HYDRAULIC MACHINES.

Laws of the Flowing of Liquids.—Determination of the Quantity Discharged.—Contracted Vein.—Parabolic Jets.—Relative Velocity of the Parts of Streams.—Undershot, Overshot, Breast-Wheels.—Common Pump.—Forcing-Pump.—Vera's Pump.—Chain-Pump.

If a liquid, the particles of which have no cohesion, flows from an aperture in the bottom of its containing vessel, the particles so descending fall to the aperture with a velocity proportional to the height of the liquid.

The force and velocity with which a liquid issues depend, therefore, on the height of its level—the higher the level the greater the velocity.

As the pressures are equal in all directions, and as it is gravity which is the cause of the flow, "The velocity which the particles of a fluid acquire when issuing from an orifice, whether sideways, upward, or downward, is equal to that which they would have acquired in falling perpendicularly from the level of the fluid to that of the orifice."

When a liquid flows from a reservoir which is not replenished, but the level of which continually descends, the velocity is uniformly retarded: so that an unreplenished reservoir empties itself through a given aperture in twice the time which would have been required for the same quantity of water to have flowed through the same aperture, had the level been continually kept up to the same point.

The theoretical law for determining the quantity of water discharged from an orifice, and which is, that "the quantity discharged in each second may be obtained by multiplying the velocity by the area of the aperture," is not found to hold good in practice—a disturbance arising from the adhesion of the particles to one another, from their friction against the aperture, and from the formation of what is designated "the contracted vein." For when water flows through a circular aperture in a plate, the diameter of the issuing stream is contracted and reaches its minimum dimensions at a distance about equal to that of half the diameter of the aperture. This effect arises from the circumstance that the flowing water is not alone that which is situated perpendicularly above the orifice, but the lateral portions likewise move. These, therefore, going in oblique directions, make the stream depart from the cylindrical form, and contract it, as has been described.

By attachment of tubes of suitable shapes to the aperture, this effect may be avoided, and the quantity of flowing water very greatly increased. A simple aperture and such a tube being compared together, the latter was found to discharge half as much more water in the same space of time.

As the motion of flowing liquids depends on the same laws as that of falling solids, and is determined by gravity, it is obvious that the path of a spouting jet, the direction of which is parallel or oblique to the horizon, will be a parabola; for, as we shall hereafter see, that is the path of a body projected under the influence of gravity in vacuo. When a liquid is suffered to escape in a horizontal direction through the side of a vessel, it may be easily shown to flow in a parabolic path. The maximum distance

to which a jet can reach on a horizontal plane is, when the opening is half the height of the liquid.

[In consequence of the motion of water, or other liquids, being subject to the same laws as falling bodies, it is evident that the velocity and quantity of water discharged at various depths in rivers would be as the square roots of those depths, provided various mechanical causes did not exist to check its force. Let $A B C D$ represent a tank of water, from which a channel, $B D F I$, slopes considerably. It will be found that the lower part of the water at D has a velocity as the square root of the depth $B D$; the water at F flows with a velocity proportioned to the square root of the depth $E F$; and the water at I as the square root $G I$. The top water at H has only a velocity equal to that of the bottom water at F , because it is the same depth from the line of

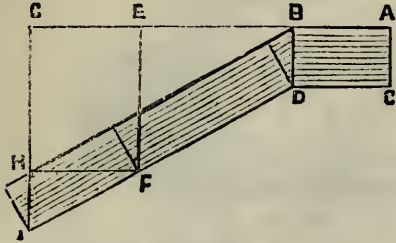


Fig. 65.

level $A B G$; and therefore, by the same rule, we may arrive at the velocity of any part of the channel.

["A very slight declivity suffices to give the running motion to water. Three inches per mile, in a smooth straight channel, gives a velocity of about three miles per hour. The Ganges, which gathers the waters of the Himalaya mountains, the loftiest in the world, at 1,800 miles from its mouth, is only 800 feet above the level of the sea—that is, about twice the height of St. Paul's church in London; and to fall these 800 feet in its long course, the water requires more than a month. The great river Magdalena, in South America, running for 1,000 miles between two ridges of the Andes, falls only 500 feet in all that distance. Above the commencement of the thousand miles, it is seen descending in rapids and cataracts from the mountains."—*Dr. Arnott's "Elements of Physics,"* p. 260.]

To measure the velocity of flowing water, floating bodies are used: they drift, immersed in the stream under examination. A bottle partly filled with water, so that it will sink to its neck, with a small flag projecting, answers very well; or the number of revolutions of a wheel accommodated with float-boards may be counted.

In any stream the velocity is greatest in the middle (where the water is deepest), and at a certain distance from the surface. From this point it diminishes toward the banks. Investigations of this kind are best made by Pictot's stream-measurer, Fig. 66. It consists of a vertical tube with a trumpet-shaped extremity, bent at a right angle. When plunged in motionless water the level in the tube corresponds with that outside, but the impulse of a stream causes the water to rise in the tube until its vertical pressure counterpoises the force.

The force of flowing water is often employed for various purposes in the arts. We have several different kinds of water-wheels, as the undershot, the overshot, and the breast-wheel. The first of these consists of a wheel or drum revolving upon an axis, and on the periphery there are placed float-boards, $a b c d e$, &c. It is to be fixed so that its lower floats are immersed in a running stream or tide, and is driven round by

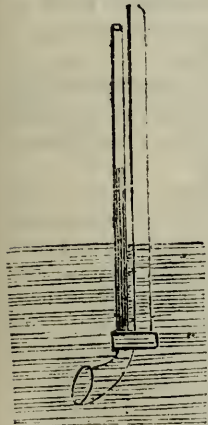


Fig. 66.

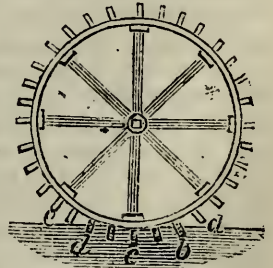


Fig. 67.

the momentum of the current.

["It is obvious that we may make the diameter of an undershot wheel as great as we please; and that, the greater the diameter, the larger will be the gain of power. But in this, as in all previous instances, what is gained in power is lost in velocity; since a given amount of movement in the water, which would carry a wheel of 12 feet in

diameter through a whole revolution, will only carry a wheel of 24 feet through half a revolution."—*Dr. Carpenter's "Mechanical Philosophy," p. 262.*

The overshot-wheel, in like manner, consists of a cylinder or drum, with a series of

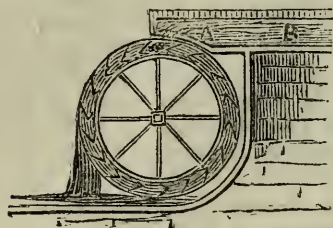


Fig. 68.

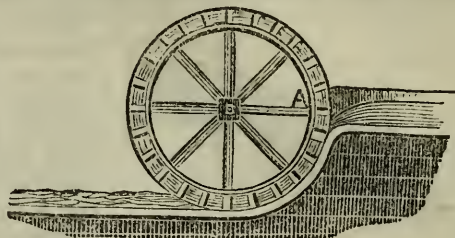


Fig. 69

cells or buckets, so arranged that the water which is delivered by a trough, A B, on the uppermost part of the wheel, may be held by the descending buckets as long as possible. It is the weight of this water that gives motion to the wheel on its axis.

The breast-wheel, in like manner, consists of a drum working on an axis, and having float-boards on its periphery. It is placed against a wall of a circular form, and the water brought to it fills the buckets at the point A, and turns the wheel, partly by its momentum and partly by its weight.

[“The most advantageous diameter of the breast-wheel will depend, like that of the overshot wheel, upon the height of the fall. It is obvious that the water does not act equally in moving the wheel, during the whole of its descent; for, as the power produced by its weight always acts in lines perpendicular to the earth’s surface, its action at A is in the direction A a, and therefore the length of leverage is only C c. By the time that the wheel has moved round, so that the weight is at B, it will act in the direction B b, and therefore with the lever power C d; and when it has arrived at D, it will act with the power of the full radius D C. It is obvious that no weight of water at E will have any influence in turning the wheel, since its pressure is in the downward direction E F; but as soon as it is acting, to the least degree, on one side of this, it will begin to exert a power which continually increases until it reaches D, after which it will diminish in the same proportion.”

—*Dr. Carpenter's "Mechanical Philosophy," p. 263.]*

Of these three forms the overshot-wheel is the most powerful.

There are a great many contrivances for the purpose of raising water to a higher level. These constitute the different

varieties of pumps.

The common pump is represented in Fig. 71. It consists of three parts: the suction-pipe, the barrel and the piston. The suction-pipe a b, is of sufficient length to reach down to the water, A, proposed to be raised from the reservoir R. The barrel, C B, is a perfectly cylindrical cavity, in which the piston, P, moves, air-tight, up and down, by the rod, d. It is commonly moved by a lever, but in the figure a rod and handle, D E, are represented. On one side is the spout, S. At the top of the suction-pipe, at O, there is a valve, v, and also one on the piston, at c. They both open upward. When the piston is raised from the bottom of the barrel and again depressed, it exhausts the air in the suction-pipe, and the water rises from the reservoir, pressed up by the atmosphere. After a few movements of the piston the barrel becomes full of water, which, at each successive lift, is thrown out of the spout, S. The action of this machine is readily understood, after what has been said of the air-pump, which it closely resembles in structure.

In the forcing-pump the suction-pipe, e R, is commonly short, and the piston, g, has no valve. On the box at O there is a valve, v, as in the former machine, and when the piston is moved upward in the barrel, C B, by the handle, E, and rod, D d, the water A,

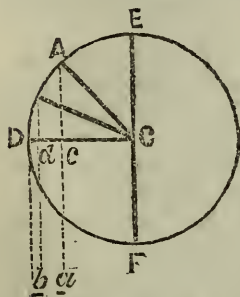


Fig. 70.

risers from the reservoir, R, and enters the barrel. During the downward movement of the piston the valve, *v*, shuts, and the water passes by a channel round *m*, through the lateral pipe, M T M N, into the air-vessel, K K. The entrance to this air-vessel at P,

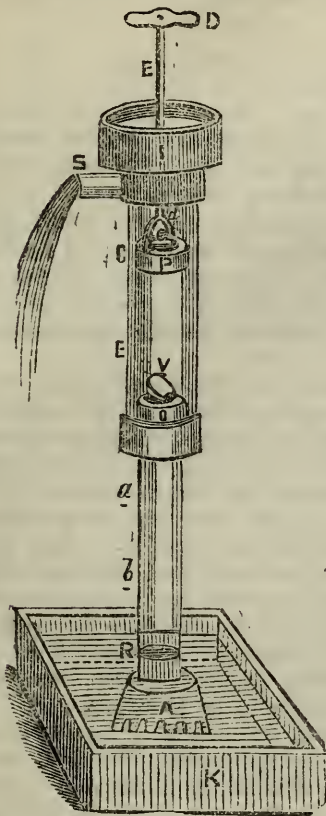


Fig. 71.

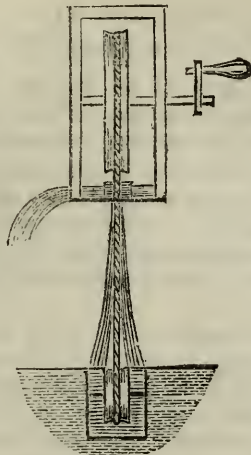


Fig. 73.

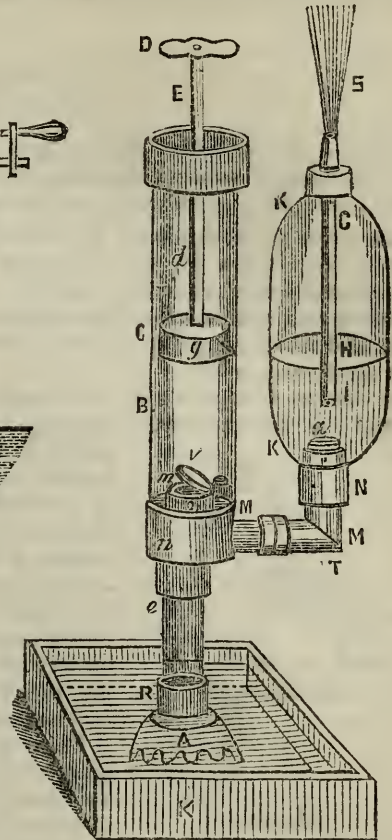


Fig. 72.

is closed by a valve, *a*, and there proceeds from it a vertical tube, H G, open at both ends. After a few movements of the piston, the lower end, I, of this tube becomes covered with water, and any further quantity now thrown in compresses the air in the space, H G, which, exerting its elastic force, drives out the water in a continuous jet, S. The reciprocating motion of the piston may, therefore, be made to give rise to a continuous and unintermitting stream by the aid of the air-vessel, K K.

Among other hydraulic machines may be mentioned Vera's pump, more, however, from its peculiar construction than for any real value it possesses. It consists of a pair of pulleys, over which a rope is made to run rapidly; the lower one is immersed in the water to be raised. By adhesion a portion of the water follows the rope in its movements, and is discharged into a receptacle placed above. (Fig. 73.)

The chain-pump consists of a series of flat plates, *d*, held together by pieces of metal, so arranged that, by turning an upper wheel, *e*, the whole chain is made to revolve, on one side ascending and on the other de-

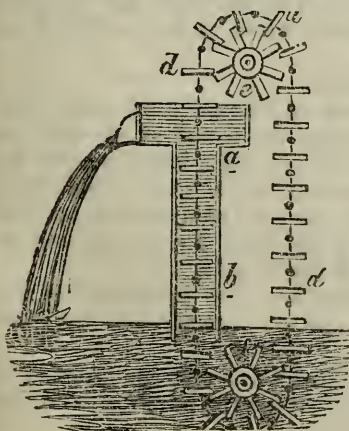


Fig. 74.

scending and passing over a lower wheel. As the flat plates pass upward they move through a trunk of suitable shape, *a b*, and therefore continually lift in it a column of water. The chain-pump requires deep water to work in, and cannot completely empty its reservoir, but it has the advantage of not being liable to be choked.

CHAPTER XIV.

HYDRAULIC MACHINES.

Archimedes' Screw.—*The Syphon acts by the Pressure of Air.*—*The Descent, Ascent, and Floating of Solids in Liquids.*—*Quantity of Water displaced by a Floating Solid.*—*Case where fluids of different densities are used.*—*Equilibrium of Floating Solids.*

THE screw of Archimedes is an ancient contrivance, invented by the philosopher whose name it bears, for the purpose of raising water in Egypt. It consists of a hollow screw-thread wound round an axis, upon which it can be worked by means of a handle. The lower end of this spiral tube dips in the reservoir from which the water is to be raised, and by turning the handle the water continually ascends the spire and flows out at its upper extremity.

The syphon is a tube with two branches, *C E*, *D E*, Fig. 75, of unequal length, often employed in the arts for the purpose of raising or decanting liquids. The method of using it is first to fill it, and then placing the shorter branch in the vessel, *B*, to be decanted, the liquid ascends to the bend and runs down the longer branch. It is obvious that this motion arises from the inequality of weight of the columns in the two branches. The long column over-balances the short one, and determines the flow; but this cannot take place without fresh quantities rising through the short branch, impelled by the pressure of the air. The syphon, therefore, is kept full by the pressure of the air, and kept running by the inequality of the lengths of the columns in its branches.

This inequality is not to be measured by the actual lengths of the glass branches themselves, but it is to be estimated by the difference of level, *A*, of the liquid in the vessel to be decanted and the free end, *D*, of the syphon.

That this instrument acts in consequence of the pressure of the air is shown by making a small one discharge quicksilver under an air-pump receiver. Its action will cease as soon as the air is removed.

By the aid of a syphon liquids of different specific gravities may be drawn out of a reservoir without disturbing one another, and those that are in the lower part without first removing those above. Upon the same principle water may also be conducted in pipes over elevated grounds.

Of the Floating of Bodies in Liquids.

A solid substance will remain motionless in the interior of a liquid mass when it is of the same specific gravity. Under these circumstances the forces which tend to make it sink are its own weight and the weight of the column of water which is above it. But as its weight is the same as that of an equal volume of the liquid in which it is immersed, this downward tendency is counteracted and precisely equilibrated by the upward pressure of the surrounding liquid. Consequently the solid remains motionless in any position, precisely as a similar mass of the liquid itself would be.

But if the density of the immersed body is greater than that of an equal bulk of the liquid, then the downward forces preponderate over the upward pressure, and the solid descends.

If, on the other hand, the solid is lighter than an equal volume of the liquid, the upward pressure of the surrounding liquid overcomes the downward tendency, and the body rises to the surface and floats.

(To be continued.)

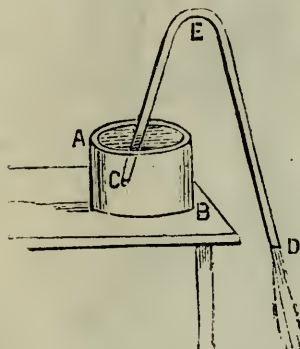


Fig. 75.

CHEMISTRY.

(Continued from page 107.)

ELEMENTS AND THEIR LAWS OF COMBINATION.

Number and Classification of Elements.—

There are fifty-six such substances or elements at present known to us. There are also several other substances which have been lately proposed as elements of the metallic class, about which, however, we know but little. About forty of the elements have the peculiar lustre, and other properties of metals, and it is customary to divide the elements into two great classes—the metallic and the non-metallic. This convenient distinction is not, however, strictly accurate, since there are several elements which, like tellurium, carbon, arsenic, silicon, &c., seem to possess an intermediate character. Only fourteen of the elementary bodies are of common occurrence, and of these the atmosphere, water, and the great bulk of the planet are composed. The remainder are comparatively rare, and are known only to the chemist. But the same laws of combination apply to the whole, and we shall best accomplish our present object by discussing the first principles of chemical philosophy, and illustrating them by a selection of facts, rather than by attempting the task of giving too much detail.

State in which the elements exist.—At common temperatures, and when set free from combination, nearly all the elements are solids. Two, mercury and bromine, are fluids, and five are gases, namely, chlorine, fluorine, hydrogen, oxygen, and nitrogen. A few only of the elements are naturally found in a free or uncombined state, among which we may name oxygen, hydrogen, carbon, sulphur, and nine or ten metals. All the rest exist in combination with each other, and so completely concealed or disguised as to be known only to the chemist.

1. *Combination by weight.*—The laws by which the elements unite to form compounds, are included in the four following propositions:—

1st LAW. A compound of two or more elements is always formed by the union of certain definite and unalterable proportions of its constituent elements.

This is the law of definite proportions.

2nd LAW. When two bodies unite in more proportions than one, these proportions bear some simple relation to each other.

This is the law of multiple proportions.

3rd LAW. When a body (A) unites with other bodies, (B, C, D, &c.), the proportions in which B, C, and D unite with A, will represent in numbers the proportions in which they will unite among themselves in case such union takes place.

This is the law of equivalent proportions.

4th LAW. The combining proportion of a compound body is the sum of the combining weights of its several elements.

This is the law of the combining numbers of compounds.

These four laws are the foundation of all chemical science, and should receive the attention which their great importance demands. We will briefly illustrate their meaning, which will be done, however, more effectually by the constant use we shall have to make of them in this volume.

Definite Proportions.—Analysis shows us that a given compound is always formed of certain elements in definite proportions, and that no change can take place in the number or proportion of its constituent elements, without destroying its peculiar character, and forming a new substance. Thus, in nine grains of water there are eight grains of oxygen and one grain of hydrogen. Any attempt to form water from any other proportion of its elements would be useless. Constancy of composition is essential to the being of chemical compounds.

Multiple Proportions.—If a body (A) unites with a body (B) in more proportions than one, thus producing more than one compound of the two elements, these proportions bear a simple relation to each other. (1.) We may have a series of compounds represented by $A + B$: $A + 2B$: $A + 3B$: $A + 4B$: $A + 5B$: in which one, two, three, four, and five parts by weight of B, unite with one part of A, forming five separate and distinct compounds. Several examples of this law will be found in the following pages. (2.) In place of the simple ratio of numbers here explained, we may have another series of compound bodies, whose elements bear to each other

an intermediate ratio. Thus the expressions, $2A + 3B : 2A + 5B : 2A + 7B$: represent a series of compounds, of which our future studies will afford us several cases.

Equivalent Proportions.—This may be considered as the most important law in chemical philosophy, and its discovery and application have been the great cause of the rapid advance of modern chemistry. Chemical analysis has shown that the body, oxygen, can form one definite compound, or more than one, with every other element yet discovered, except perhaps fluorine. The compounds of oxygen with the elements being perfectly definite, (183), can all be expressed in numbers, which numbers will truly express the combining weights of the several bodies. For the sake of illustration, let us assume that it requires eight parts by weight of oxygen to unite with each of the other elements, and that these eight parts require various weights of the several elements. We can then make a table which shall correctly express these numerical relations.

Thus, 8 parts of oxygen unite with....	{	6 parts of carbon.
		1 part of hydrogen.
		35·41 parts of chlorine.
		108·12 of silver.
		27·14 of iron.
		101·27 of mercury.
		16·09 of sulphur.

And we might go on thus through the whole list of elementary substances, analyzing their several compounds with oxygen, and setting down the combining numbers of each in one table. The few examples given above are, however, sufficient for our purpose. Oxygen is selected as the term of comparison for the other bodies, because it almost universally unites with the several other elements. The number 8 is attached to it, because hydrogen, which is made the unit in our books, enters into combination in a smaller proportion than any other body. We might with equal propriety make oxygen unity, when hydrogen would be expressed by a fractional number. But taking oxygen at 8, all the other numbers expressing the combining weight of each element have been determined with great care, by often repeated analyses. Let it be understood, then, that if any of the bodies in the

table should form compounds with each other, the weights in which they will unite will be in the exact proportion of the numbers severally affixed to them. Thus, if hydrogen unites with chlorine to form a new compound (hydro-chloric acid), it will require one part of hydrogen to 35·41 parts of chlorine to form such compound. One pound of hydrogen will unite to 35·41 pounds of chlorine, and will form 36·41 pounds of the compound. Any excess or deficiency of either of the elements will make no difference with the result, and the above law will in all cases be found strictly true. If sulphur and mercury unite to form a third body, it will be only in the proportion of the numbers 16·09 and 101·26; and if sulphur unite with iron, it will be as 16·09 : 27·14.

We see, then, that the several numbers are truly the equivalents of each other, as they are all the equivalent of oxygen, and are, therefore, most appropriately called *equivalent proportions, or equivalent numbers.*

Table of Chemical Equivalents.—In the following table, the equivalent or combining numbers of all the elementary bodies are given in accordance with the latest and best authorities. Two columns of combining proportions are given; in the first, hydrogen, and in the second, oxygen, is used as the unit of comparison. Because hydrogen enters into combination with other bodies in a smaller weight than any other known element, it has generally been used in Great Britain and in this country as the basis of the scale of equivalent numbers. It was also believed, and is still by some good chemists, that the numbers expressing the combining weights of all bodies would be found, on more accurate research, to be simple multiples of the unit of hydrogen. If this view were correct, it would give us the great convenience of avoiding fractional numbers. But the most rigid experiments have failed to prove this idea to be true, and as it has no necessary foundation in the nature of things, we are not at liberty to adopt it. Berzelius, and most European chemists, assume oxygen as 100; and the second column of figures in the table gives the equivalents according to this scale.

Those elements marked with a * are rare, and comparatively unimportant.

TABLE OF ELEMENTARY SUBSTANCES, WITH THEIR EQUIVALENTS AND SYMBOLS.

	Sym- bol.*	H = 1, or Oxy. = 8.	Oxy. = 100
Aluminum	Al	13.69	171.17
Antimony	Sb (1)	129.04	1612.90
Arsenic	As	75.21	940.08
Barium	Ba	68.55	856.88
Bismuth	Bi	70.95	886.97
Boron	B	10.90	136.20
Bromine	Br	78.26	978.31
Cadmium	Cd	55.74	696.77
Calcium	Ca	20.	250.
Carbon	C	6.	75.
*Cerium	Ce	45.98	574.70
Chlorine	Cl	35.41	442.65
Chromium	Cr	28.14	351.82
Cobalt	Co	29.52	368.99
Columbium ..	Cm	184.59	2307.43
Copper	Cu (2)	31.65	395.70
*Didymium	Di		
Fluorine	F	18.70	233.80
*Glucinum	G	26.50	331.26
Gold	Au (3)	99.44	1243.
Hydrogen	H	1.	12.5
Iodine	I	126.36	1579.50
*Iridium	Ir	98.68	1233.50
Iron	Fe (4)	27.14	339.21
*Lanthanum ..	Ln		
Lead	Pb (5)	103.56	1294.50
Lithium	L	6.43	80.33
Magnesium	Mg	12.67	158.35
Manganese	Mn	27.67	345.89
Mercury	Hg (6)	101.26	1265.82
*Molybdenum ..	Mo	47.88	598.52
Nickel	Ni	29.59	369.68
Nitrogen	N	14.06	175.75
*Osmium	Os	99.56	1244.49
Oxygen	O	8.	100.
*Palladium	Pd	53.27	665.90
Phosphorus	P	31.38	392.28
Platinum	Pl	98.68	1233.50
Potassium	K (7)	39.19	489.92
*Rhodium	R	52.11	651.39
Selenium	Se	39.57	494.58
Silicon	Si	22.18	277.31
Silver	Ag (8)	105.12	1351.61
Sodium	Na (9)	23.27	290.90
Strontium	Sr	43.78	547.29
Sulphur	S	16.09	201.17
Tellurium	Te	64.14	801.76
*Thorium	Th	59.59	744.90
Tin	Sn (10)	58.82	735.29
*Titanium	Ti	24.29	303.69
*Tungsten	W (11)	94.64	1183.
*Vanadium	V	68.55	856.89
*Uranium	U	60.	750.
*Yttrium	Y	33.20	402.51
Zinc	Zn	33.00	412.50
*Zirconium	Zr	33.62	420.20

* In the symbols, the Latin names of the elements are employed. Eleven of these are not in common use, viz.: (1.) Stibium, (2.) Cuprum, (3.) Aurum, (4.) Ferrum, (5.) Plumbum, (6.) Hydrargyrum, (7.) Kalium, (8.) Argentum, (9.) Natrium, (10.) Stannum, (11.) Wolframium, (from

It is obvious that the numbers of the oxygen scale are just twelve and a half times as large as those in the hydrogen scale; consequently, dividing the oxygen equivalents by 12.5 will give the hydrogen numbers, and multiplying the latter by the same sum will give us the oxygen numbers.

Combining numbers of compounds.—It has been stated that the equivalent or combining proportion of a compound body is always the sum of the combining equivalents of its elements. Strict experiment has established this important law, which will receive constant illustration as we go on; at present, however, we must accept it as truth, and not anticipate, by attempting to give examples which cannot be well understood until we have become somewhat familiar with chemical language, symbolic illustration, and the laws of affinity.

Combination by Volume.—Gaseous bodies, whether elementary or compound, combine not only in accordance with the laws just explained, but also according to a peculiar law of their own, whereby certain volumes of each are required. The volumes in which gaseous bodies unite, are either 1 to 1, or 1 to 2, or 1 to 3, &c. Thus water is formed of 2 volumes or measures of hydrogen, and 1 volume of oxygen. In combining, these three volumes are condensed into 2. If we take oxygen, hydrogen, chlorine, and nitrogen, in the proportions by weight in which they combine, or measure the volumes they occupy as gases, a very obvious relation will be observed between them; the volume of oxygen being exactly one half that of each of the others. Thus,

8 grains of oxygen occupy	23.3 cubic inches.
1 grain of hydrogen	46.7
35.41 grains of chlorine	46.2
14.06 grains of nitrogen	46.5

The same is true of compound gases, and also all bodies which can be raised in vapour, as sulphur, iodine, and mercury. Solids, which combine with gases, are subject to the same law. Sulphur has $\frac{1}{3}$ the volume of oxygen, and mercury 4 times.

the mineral Wolfram.) Columbium is frequently represented by the symbol Ta, from Tantalum, a name by which the European chemists distinguish this metal.

We can state this truth in another form. If we call the weight of a volume of oxygen 1000, then an equal volume of hydrogen will weigh 0.0625, and these numbers will represent the relative specific gravity of the gases. But in water, two volumes of hydrogen unite with one of oxygen, and we must, therefore, double the above hydrogen number, $2 \times 0.0625 = 0.125$. Now these numbers, 1000 and 0.125, are exactly the equivalent numbers on the oxygen scale, 100 and 12.5 or making hydrogen unity, then we have $100.0 \div 12.5 = 8$ ox., and $0.125 \div 12.5 = 1$ hyd. This relation between the specific gravity of gaseous bodies, and their combining number, or chemical equivalents, is universally true, and we might give a long table including these relations: but the following examples will answer:

Gases and vapours.	Specific Gravities.		Chemical Equivalents.	
	Air = 1.	Hydrogen = 1.	By volume.	By weight.
Hydrogen	0.069	1.	100 or 1	1.
Nitrogen	0.972	14.03	100 or 1	14.06
Oxygen	1.111	16.	50 or $\frac{1}{2}$	8.
Chlorine	2.470	35.64	100 or 1	35.41
Iodine vapour ..	8.701	126.30	100 or 1	126.36
Bromine vapour.	5.398	78.	100 or 1	78.26
Mercury vapour.	6.969	101.	200 or 2	101.27
Sulphur vapour.	6.648	96.54	16.66 or $\frac{1}{6}$	16.09

When the numbers in the second column are the same as the equivalents, (or with only a fractional difference,) then a volume represents an equivalent. The other numbers are multiples of the equivalent. Thus $1 \times 8 = 16$, the number for the density of oxygen, and sulphur $16 \times 6 = 96$, the density of sulphur vapour.

Conclusions.—(1.) If we know the proportions by volume in which 2 gases combine, and also their specific gravities, we can calculate the composition of the compound by weight. (2.) Or we can foretell the density of a compound by knowing the volumes and specific gravities of its elements. (3.) If we know the volume and specific gravity of one of the two elements of a compound, and of the compound itself, we can then calculate its composition by weight. (4.) If we know the specific gravity and composition of a compound by weight, we can then calculate its composition by volume. Many examples will be found in elemen-

tary chemistry of the practical application of these rules.

Chemical Nomenclature and Symbols. Names of the Elements.—Some of the elementary bodies have been known from the remotest antiquity, and were in common use long before the science of chemistry was heard of. Thus several metals, as Copper (*Cuprum*), Gold (*Aurum*), Iron (*Ferrum*), Mercury (*Hydrargyrum*), Silver (*Argentum*), Lead (*Plumbum*), Tin (*Stannum*), have long been known either by the names we now give them, or by those Latin terms of which our English names are translations. No descriptive meaning is conveyed by such terms as these, nor by such as sulphur and carbon. The alchemists named the metals after the various planets.

Thus, Gold was called *Sol*, the Sun; Silver, *Luna*, the Moon; Iron, *Mars*; Lead, *Saturn*; Tin, *Jupiter*; Quicksilver, *Mercury*; and Copper, *Venus*. Hence formerly the astronomical signs or symbols of these planets were employed by alchemists and mineralogists to represent the names of these metals, and they are still in use in some countries.

Several of the elements have been named from some prominent or distinguishing physical property of colour, taste, or smell, which they possess; thus Bromine is so called from the Greek word *bromos*, fetor; Chlorine, from *chloros*, green, in allusion to its greenish colour; Chromium, from *chroma*, colour, because it makes highly coloured compounds, as *chrome-yellow*; Glucinum from *glukus*, sweet, from the sweet taste of its salts; Iodine, from *ion*, a violet, and *eidōs*, in the likeness of; and so for many others.

Another class of names has been contrived from what was supposed to be the characteristic attribute of the body in combination. Thus, Oxygen was so named because many of its compounds are acids, from the Greek, *oxus*, acid, and *gennao*, I produce. Hydrogen is from *udor*, water, and *gennao*, I produce. We might thus go through the whole list, but it is unnecessary, as we shall have again to give the etymology of these words when we speak of each element.

Names of Compounds.—All chemical compounds derive their names from one or more of their constituents, according

to certain fixed and simple rules, which we must very briefly explain. When two elements unite, the compound is called *binary*, from *bis*, twice; thus water, sulphuric acid, oxide of silver, and oxide of iron, are binary compounds. Compounds of binary combinations with each other, as of sulphuric acid with soda, forming sulphate of soda, or Glauber's salts, (and the salts generally so called), are called *ternary* compounds (from *ter*, thrice.) Compounds of salts with each other (as in the case of alum, which is a compound of sulphate of potash and sulphate of alumina), are named *quaternary* compounds, from *quatuor*, four.

All the compounds of oxygen with the other elements are called either oxides or acids. Thus, water in chemical language is the oxide of hydrogen; the chemical name of potash is the oxide of potassium. It has been before stated that oxygen forms compounds with all the other elements. Some of these compounds have what we commonly call acid* properties: thus, the compounds of oxygen and sulphur are called acids, and not oxides. Oxides are divided into two classes; (a) neutral oxides, like water; (b) alkaline† oxides and bases,‡ like potash, alumina. When the same element unites with oxygen in more than one proportion, forming two or more oxides, then they are distinguished by the Greek prefix, *proto*, (*protos*, first), applied to that body which has the least portion of oxygen, which is called the *protoxide*; *deuto* (*deuteros*, second), is prefixed to the next degree of oxidation, giving us the term *deutoxide*; *trito* (*tritros*, third), to the body containing still more oxygen than the deutoxide. The oxide which contains the largest dose of oxygen with which the body is known

to unite, is also called the *peroxide*, from the Latin *per*, which is a particle of intensity in that language. Thus there are two oxides of hydrogen, the protoxide (water) and the peroxide; there are three oxides of manganese; (1.) the protoxide; (2.) the deutoxide; (3.) the peroxide of manganese. Some oxides are formed in the proportion of 2 to 3, or once and a half. Such oxides are distinguished by the term *sesquioxides*, from the numeral *sesqui* (once and a half). Certain inferior oxides are called *suboxides*.

The binary compounds of chlorine, and some other elements which resemble oxygen in their manner of combination, and in their relations to electrical decomposition, are also distinguished in the same manner as oxygen. Thus, with the other elementary bodies:

Chlorine forms Chlorides.

Bromine „ Bromides.

Iodine „ Iodides.

Fluorine „ Fluorides.

Oxygen „ Oxides.

(1.) The binary compounds of sulphur analogous to the oxides are called *sulphurets*, and not *sulphides*. The prefix *bi* (double) is more commonly used before the compounds of chlorine, sulphur, &c., than *deuto*, which is used before the oxides. Thus, it is more usual to say bichloride of carbon, and bisulphuret of iron, than deutochloride of carbon, and deutosulphuret of iron. When the name of the element to which this prefix is made begins with a vowel, the consonant *n* is introduced as making a more euphonious word; thus we say biniodide of lead, rather than biiodide of lead. Compounds of phosphorus and carbon with electro-positive elements, are distinguished by the termination *uret*, like those of sulphur; thus, we say the sulphuret of carbon, carburet of iron, and phosphuret of lead. In all such cases, the name of the element which most resembles oxygen (*i. e.* the electro-negative element), is that which stands first in the name of these compounds, and which has the termination affixed to it. Thus, one of the compounds of chlorine and phosphorus is called "chloride of phosphorus," and not "phosphuret of chlorine;" "sulphuret of carbon," and not "carburet of sulphur."

The acid compounds of oxygen are

* Acids are known by their taste in some cases, and by their power of turning the vegetable blues to red; but more particularly by their power of uniting with and saturating alkalies and other bases.

† Alkalies are soluble bodies, with a hot, acrid taste, which have the power of saturating acids, and of turning the reddened vegetable blues to blue or green.

‡ Base is a term given to all oxides which are not acids: it is a more general and comprehensive term than alkali. In fact, all bodies, simple and compound, are properly divided into bases and acids, or electro-positive and electro-negative bodies.

named from the substance in combination with the oxygen, with the addition of the termination *ic*, the word acid being always appended. Thus, one of the compounds of nitrogen and oxygen is termed *nitric acid*; of chromium and oxygen, *chromic acid*.

If two acid compounds of oxygen are formed with an element, the termination *ous* is applied to that which has the least oxygen; thus we have *sulphurous acid*, and *sulphuric acid*, as the names for two very dissimilar acids of sulphur.

Sometimes a compound has been discovered containing less oxygen than that compound which has already received the termination *ous*; then the term *hypo* is prefixed (from the Greek *upo*, under), and we then have the term *hyposulphurous*; or *hyposulphuric*, provided an intermediate compound is formed between the sulphurous and sulphuric acid. On the same plan, we say *hyperchloric acid* (from *uper*, above), to distinguish the acid of chlorine having a higher proportion of oxygen than *chloric acid* before named; *perchloric acid* has the same meaning, and may be used with equal propriety. All other analogous acids are named on precisely the above principles.

Sulphur acids and hydrogen acids are those where sulphur and hydrogen take the place of oxygen. Thus, sulpharsenic acid is an acid compound of arsenic and sulphur. Hydrochloric acid is the acid formed from the union of hydrogen and chlorine.* In the same way, we have hydrobromic, hydrofluoric, and hydriodic acids, as acids of bromine, fluorine, and iodine.

(2.) Ternary compounds, or salts, are named from the acid which they contain; the termination *ic* being changed into *ate*, and *ous* into *ite*. Thus, the salt formed from the union of soda and nitric acid is called the *nitrate* of soda, and that formed with nitrous acid is called *nitrite* of soda; the salts of hyponitrous acid are called hyponitrites, and of hyperchloric acid, hyperchlorates, &c. The species is always indicated by the oxide; thus, the nitrate of lead is the same as the nitrate of the

oxide of lead, and nitrate of soda is the same as nitrate of the oxide of sodium; the word oxide being understood, is generally omitted. A bisulphate has twice, and a sesquisulphate once and a half as much acid as a sulphate. The excess of base in subsalts is sometimes expressed by the Greek prefix *di*, twice; thus, the dichromate of lead has twice as much of the base lead as the chromate of lead.

(3.) *Quaternary Compounds*.—The double salts are named from their bases; thus, alum, which is formed of sulphate of alumina and sulphate of potash, is called double sulphate of alumina and potash. The chloride of potassium and platinum is another double salt, formed from the union of a chloride of platinum and chloride of potassium.

The chemical nomenclature, when once understood, enables us, after a little use, to form, in most cases from the mere name of the compound substance, a correct idea of its composition, and of the proportions of its constituents. This great advantage is possessed by no other science, and cannot be too highly estimated. There are a good many compounds, however, that have been discovered of late years, for which this nomenclature provides no names. But we have certain written expressions, by means of which we can convey an idea of all chemical compounds with a mathematical precision and great convenience.

PROPER DISTRIBUTION OF TIME.—Time we ought to consider as a sacred trust, committed to us by God; of which we are now the depositaries, and are to render an account at the last. That portion of it which he has allotted to us is intended partly for the concerns of this world, partly for those of the next. Let each of these occupy, in the distribution of our time, that space which properly belongs to it. Let not the hours of hospitality and pleasure interfere with the discharge of our necessary affairs; and let not what we call necessary affairs encroach upon the time which is due to devotion. To everything there is a season, and a time for every purpose under heaven. If we delay till to-morrow what ought to be done to-day, we overcharge the morrow with a burden which belongs not to it.

* In strict uniformity to rule, the term *chlorohydric* is correct, but use has established the other. The same remark is true of bromohydric and iodo-hydric acids.

PRACTICAL LESSONS IN DRAWING.*

1. INTRODUCTION.

AT the request of many of our young friends, we intend to give a series of elementary lessons in drawing, by a practised hand, which we have no doubt will greatly facilitate the pupil in this delightful art.

It has been aptly said, that "there is no royal road to learning," and drawing does not tend to disprove the truth of the adage; on the contrary, it confirms the justice of the remark.

Our present purpose is to give such clear and concise rules, that any person totally ignorant of the principles of the art, and even those incapable of making a straight line, may be soon taught to draw correctly and creditably. To attain to this point, strict and careful attention to the rules we shall give, frequent practice of these and other copies, and the study of good paintings and engravings, is absolutely necessary.

Remember that "practice makes perfect," and therefore let this be your motto; and if you persevere, and adhere to the rules we shall give from time to time, you will become a proficient in the art.

It is frequently said, that

"Without true genius, vainly you aspire!
Without sound elements, in vain your fire!"

but let me request you not to be deterred by the first line in the distich; rather remember the second, and *hope* that you *have* genius which will one day develop itself. What is the use of genius without knowledge? Why, about as much as a man-of-war without guns.

We shall lead our students in drawing on, step by step, until at length they will be able to sketch a landscape from Nature, a figure, statue, and other objects, easily and correctly. This will be another great step in the art; they will then have to study geometry, perspective, proportions,

* To those of our Pupils who are commencing drawing, we would recommend the "Smith and Dolier System of Drawing Copy-books," complete in six numbers, to be had together or separately, price 6d. each, and published by W. S. Orr & Co., London. The ingenious manner in which the student is conducted step by step to a proper knowledge of the rudiments of the art, is excellent.

light, shade, reflection, and, last of all, colouring.

It is our intention to treat of all branches of drawing and painting, and in doing so we shall not follow the general plans laid down by teachers. Our plan is our own, be it good or bad; and it may be well to explain some of its principles at the onset.

We shall not treat of geometry first—although it is decidedly the basis of drawing—because it is apt to give students a distaste for the art. Our object is to make them familiar with the use of the pencil, and then we shall commence our geometrical lessons. We wish our pupils to bear in mind that little motto "Patience and perseverance," and to remember that it is almost as easy to learn to draw as to learn to write; but both require certain rules, and without attention to them perfection cannot be attained, nor even mediocrity. Sir Joshua Reynolds remarked that rules were not the fetters of genius, but only fetters to those who have not any genius; and Mr. Harding says that, "if commenced with right principles, and governed by well-directed study, skill in art may be brought within the reach of all who desire to possess it." You should endeavour to become something greater than a mere copyist in style; strive to invent, to originate, or at least to improve.

With these remarks we will commence our

FIRST LESSON.—*The necessary materials* for commencing pencil drawing will be a sharp penknife; three black-lead pencils, marked H B, F, and B; and some drawing paper, or cartridge paper, or a drawing-paper book. We advise students to use cartridge paper to begin with, and to have it cut into sheets, which should be

numbered at the upper right-hand corner, and when finished deposited in a box or strong portfolio.

To cut your pencil properly. — As you cannot draw until your pencils are cut, we must request you to cut them, not like *b* in fig. 1, which is hacked; but cut it to



Fig. 1.

a point, like *a*, fig. 1. In cutting it properly you must not remove too much of the wood, but only sufficient to expose a small part of the lead; if too much of the lead is exposed, it will break.

Do not use India - rubber at first, but rather let your blunders remain upon your sheet of paper, to stare you in the face afterwards, and chronicle your improvement. It is a great mistake with teachers generally, that they correct the exercises of their pupils, so that the parents think that their children are progressing much better under the tuition of Mr. B— or Mr. P—, than young Jones or Smith of their acquaintance, who learns of Mr. G—. The day of trial comes, and the pride of the fond parents suffers a great downfall.*

Position during drawing.—It is of great importance that the student should sit to draw in a proper position. Do not have a low table, which obliges you to poke your nose almost upon the paper, and press your chest against the edge of the drawing desk; but sit in an easy, upright position, with your feet straight before you, the left hand resting upon the edge of your paper, so as to keep it steady; the copy *before* you and *nearly upright*, and the sheet of paper upon which you are to draw slightly elevated.

The proper position to hold your pencil is the same as that directed for a pen, only it should be held so that the ends of the fingers are about an inch and a half from the point; and the pencil should not be held *too tight*, the elbow being kept well in towards the side, but not too stiff; by this means you will have perfect freedom of the hand, and complete command of the pencil.

SECOND LESSON.—As you are now prepared to commence your drawing, please seat yourself properly at the table, and make an effort to form *straight* horizontal lines, like *a* (fig. 2), and observe that they are to be parallel, and at equal distances from one another. When you have succeeded in drawing a dozen of these lines the size of the copy, you should then try to form some twice the length, and then go on increasing the length of them until you are able to draw lines a yard in length with a piece of chalk upon a black board.

To draw horizontal straight lines.—First

make a dot upon the paper where you are to commence, and another where the line is to terminate (as *c*, fig. 2); then draw a

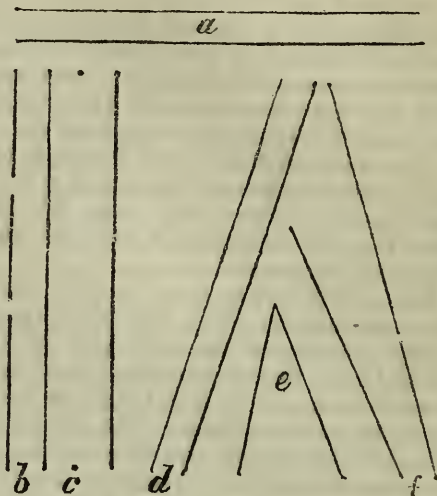


Fig. 2.

line, between the two, from left to right, the same as between these two points.

:
Continue to do this until you are able to draw the lines straight and horizontal; then practise making perpendicular lines.

To draw perpendicular straight lines, proceed the same as if drawing horizontal lines; that is, by making dots or points first, and commence with short lines, like the upper one of *b* (fig. 2). Then increase the length, until they double and quadruple the original ones.

When you have succeeded in drawing either horizontal or perpendicular straight lines, repeat the exercises with the different pencils, so as to give greater breadth to some lines than to others; and sometimes draw the lines very close together, at other times very wide apart, and afterwards fill up the intervening spaces with lines. By this means you will acquire a correct eye and idea of the rudiments of form and proportion.

To draw oblique lines, you should place the dots upon the paper as usual, and practise forming lines from right to left (as *d*, fig. 2), and afterwards from left to right (as *f*, fig. 2). When you have acquired sufficient command of your pencil to form the various lines correctly, quickly,

and freely, join two of them together, so as to appear like *c* (fig. 2).

The pupil is particularly recommended to draw oblique lines in every direction and degree of inclination, so as to gain a command of the pencil. We frequently hear pupils exclaiming, "Oh! I cannot draw that; if it was the other way, I could do it." Never indulge such ridiculous fancies, but rather endeavour to overcome a difficulty, if such exists, than allow *it* to overcome you.

Draw the lines, whether they be oblique or slanting, perpendicular or upright, and horizontal or in a line with the floor, in every kind of manner, sometimes beginning at the right hand side and sometimes at the left; at one time at the top of the line, at another at the bottom of it. Do this, practise often, strive to overcome all obstacles, and depend upon it you will accomplish wonders.

As you have learned to draw straight lines parallel to one another, it will be necessary to make you connect them in some way, so as to form the outline of an object.

Draw two straight lines parallel to one another (like *a*, in fig. 3); then connect

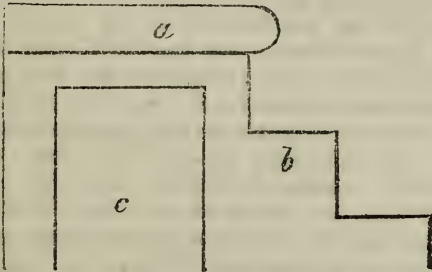


Fig. 3.

the ends of them by a small curved line, and from that draw a short perpendicular and a short horizontal line (as *b*, in fig. 3); repeat, until the outline of a set of steps is complete.

Draw a horizontal straight line, and from either extremity of it draw two perpendicular straight lines (as in *c*, fig. 3).

Draw two oblique lines, so that their lower extremities shall meet (as in *a*, fig. 4). Then draw two parallel straight lines, so that the beginning of the upper one shall be almost immediately over the end of the lower one, and join the ends

of these lines with oblique lines (as *b*, in fig. 4).

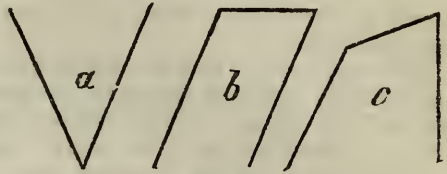


Fig. 4.

Draw a perpendicular straight line, and from the upper end of it, an oblique line from right to left, then unite the end of the oblique line to another oblique line (as in *c*, fig. 4).

(To be continued.)

SYSTEM OF ELOCUTION.

(Continued from page 109.)

SECTION II.—PITCH.

Pitch is the degree of the elevation of sounds.

As pitch regards the elevation of sounds, it respects their acuteness and gravity. I use the term *pitch* in its widest signification. In the science of music, it is used not only in the sense in which I employ it, but it also has a special application: in the latter, it is applied to the medium note, the regulating note to which instruments are brought by the act of tuning. When applied in this sense, it is termed concert-pitch. The note which has been adopted, by common consent, as the pitch-note, is A, the open note of the second string of the violin: it is written in the second space of the treble staff.

A *lax* division of pitch is into high and low; in other words, into acute and grave; (those notes being called high, or acute, which are above the *natural* pitch of the voice; and those low, or grave, which are below it).

Strictly speaking, the application of *high* and *low*, to pitch, is without philosophical foundation: it has originated, not from any principles in the acuteness and gravity of sound, but from the relative position of the notes in the graphic scale. This is obvious from the fact that the degrees of the scale may be exemplified in a horizontal line, by varying the forms of

the graphic notes, as was done by the Greeks.

An *exact* division of pitch, as demonstrated by the diatonic scale, is into tones and semitones.*

The word *tone*, as here employed, signifies a certain degree of difference in pitch between two notes, as that between the first and second note of the scale. But in some cases we use the word *tone*, as synonymous with *note*; for instance, in some persons the tones of the voice are more musical than in others—that is, the *notes* of the voice.

The diatonic scale consists of seven sounds, moving discretely from grave to acute, or from acute to grave, by different degrees of pitch, of which the semitone may be the common measure, or divisor, without a fraction. The scale, however, is not complete without the octave, which is a repetition of the first note in the eighth degree.

The notes do not ascend by equal degrees of pitch, but by tones and semitones; the semitones occurring between the third and fourth, and seventh and eighth. The order of the scale, therefore, is as follows: two tones and a semitone, three tones and a semitone. And should it be desirable to extend the series of sounds, the eighth note of the first octave will become the first note of the second octave; the eighth note of the second octave, the first note of the third, and so on.

In teaching the pupil to “raise and fall the eight notes,” as it is called, the monosyllables, Do, Re, Mi, Fa, Sol, La, Si†, may be employed.

Diagram 4 is a graphic representation of the scale. The heavy, horizontal, parallel lines, represent the notes; and the spaces between them, the consecutive intervals of the scale.

An interval is a difference in pitch. Intervals are either discrete, or concrete. A discrete interval is the difference in pitch between any two notes, which vary

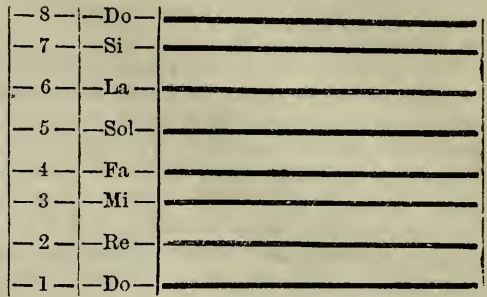


Diagram 4

from each other in acuteness and gravity. A concrete interval is that portion of the scale through which the voice slides on a concrete of speech.

The difference in pitch between the first and second note of the scale, is called the interval of a tone, or second; between the second and third, a tone; between the third and fourth, a semitone; between the fourth and fifth, a tone; between the fifth and sixth, a tone; between the sixth and seventh, a tone; between the seventh and eighth, a semitone.

The difference in pitch between the first and third note of the scale, is called the interval of a third; between the first and fourth, the interval of a fourth; between the first and fifth, the interval of a fifth; between the first and sixth, the interval of a sixth; between the first and seventh, the interval of a seventh; between the first and eighth, the interval of an octave.

The intervals between the first and third, fourth and sixth, and fifth and seventh, are called major thirds, because they contain two tones, or four semitones; but as the intervals between the second and fourth, third and fifth, and sixth and eighth, contain but three semitones, they are denominated minor thirds.

In the expression of our thoughts by oral language, we employ three sorts of voice—the *natural voice*, the *false voice*, and the *whispering voice*, which I shall now attempt to describe.

The medium compass of the voice, in those whose voices have been properly cultivated, is three octaves.* There is, however, a point of pitch at which the voice, in ascending the scale, is said to

* DIATONIC (Greek *δια*, by or through, and *τονος*, sound).—ascending or descending by sounds, whose proximate intervals are not more than a tone, nor less than a semitone.

† Pronounced Dô, Râ, Mè, Fâ, Sòl, Lâ, Sè.

* It is said that the ear is capable of perceiving nine octaves.

break. This point, in a majority of persons, is about two octaves above the lowest note of the voice. The natural voice embraces all the notes below this point; the falsetto, all the notes below it. (See Diagram 5.)

The Italians call the natural voice *voce di petto*, and the falsetto voice *voce di testa*;^{*} because they suppose the former to come from the chest, and the latter from the head. This error has arisen from a want of anatomical and physiological knowledge of the vocal organs. Voice is never formed in the chest, or in the head; it is always formed in the upper part of the larynx, at the aperture of the glottis. It is, however, formed higher, or lower in the throat, according to its degree of acuteness or gravity. At the command of the will, the larynx may be elevated or depressed and the aperture of the glottis enlarged or diminished. The larynx is the most

depressed, and the aperture of the glottis the most dilated, when the gravest sound is formed; and the larynx is the most elevated, and the aperture of the glottis the most contracted, when the acutest sound is formed. Hence grave sounds appear to come from the chest, and acute ones from the head, or roof of the mouth. From this circumstance, no doubt, has arisen the error of calling the natural voice *voce di petto*, and the falsetto voice *voce di testa*.

The whispering voice does not, like the natural voice, and the falsetto, owe its peculiarity to pitch, but to the absence of

what is generally understood by the term *vocality*. The compass of the whispering voice is about an octave. My own extends through ten degrees of the scale.*

The natural pitch of the female voice is an octave above that of the male voice. The pitch of the female voice corresponds to that of the violin; the pitch of the male voice to that of the violincello. The voices of the boys are of the same pitch as the female voice—one octave above a man's voice. When boys are about the age of fourteen, their voices undergo a change of pitch.

The notes of the falsetto voice are called *treble*; the upper notes of the natural voice, *tenor*; and the lower notes of the natural voice, *bass*.† (See Diagram 5.)

The divisions of the voice, as given by Italian authors, and adopted by many musicians of other countries, are as follows:

"There are three departments in the human voice, viz., the high, the middle, and the low. These departments are in the female, as well as in the male voice. *Soprano*, *mezzo soprano*, and *contralto*, are female voices. *Tenore*, *baritono*, and *basso*, are male voices."

The reader will observe that the *falsetto* voice is not included in the above division.

To a bass, a baritone, and a contralto voice, naturally good, or made so by cultivation, Dr. Rush applies the term *orotund*.

The notes of music are named after the first seven letters of the alphabet, and are represented by *graphic* notes, which are written on five horizontal, parallel lines, and in the intermediate spaces. These lines and spaces are called the *staff*. The lines and spaces of the staff are counted upward, that is, the lowest line of the staff is called the first line, the one above it the second line, and so on; the lowest space is called the first space, the next the second space, and so on. Each line, and each space, is called a degree. Hence, as there are five lines, and four spaces, the staff includes nine degrees.

* Notes analogous to those of the whispering voice, may be made on the German flute, and some other wind instruments, through the compass of an octave.

† When I speak of the voice, I speak of the adult male voice, unless otherwise stated.

* *Voce di petto* (Italian), voice from the breast. *Voce di testa*, voice from the head.

When it is desirable to extend the notes above or below the staff, short lines, called ledger lines, are employed.

As the great scale of sounds, which includes all the notes that can be made by instrumental means, is very extensive, it has been found convenient to divide it into two parts, and allot a staff to each part. The notes in the upper division of the great scale are written on what is called the *treble staff*; those in the lower division, upon what is denominated the *bass staff*.

To distinguish between the two staves,* and to determine the names of the graphic notes, and the sounds which they represent, characters called *cleffs* are placed at the beginning of each staff.

The treble cleff is called G, because a particular G note is written upon that line of the staff on which the main part of this character is placed. This note, called the *G cleff note*, occupies that point of pitch at which the falsetto voice generally commences.

The bass-cleff is called F, because a particular F note is written upon that line of the staff which this character crosses. The pitch of this note, called the *bass cleff note*, is nine degrees of the diatonic scale below that of the treble cleff note, and one octave above the lowest note of

the majority of bass voices which have been properly cultivated.

The usual compass of a modern grand piano-forte, is six octaves. The keys of the piano, like the notes which they severally produce, are named after the first seven letters of the alphabet: the key which produces the F note is called the F key; that which produces the G note, the G key; that which produces the A note, the A key, and so on.

The finger-board of the piano consists of white and black keys. The instrument is so constructed, that if you touch the white keys in their consecutive order, a diatonic series will be produced; but if you touch all the keys, white and black, in their consecutive order, a semitonic series will be the result.

In the diatonic scale, there are five tones and two semitones. There are, however, two varieties of the scale: one is called the *major mode*; the other, the *minor mode*. In the major mode, the first semitone is between the third and fourth degree of the scale; the second, between the seventh and eighth. The minor mode, in ascending, has the first semitone between the second and third degree; the second, between the seventh and eighth; but in descending, the second semitone is between the fifth and sixth.

Diagram 6.

No. 1.			No. 2.			No. 3.			No. 4.		
Do	8	C	.....	.....	.....	.....	.....	.....	13	C	.....
Si	7	B	.....	.....	.....	.....	.....	.....	12	B	.....
La	6	A	.....	La	8	A	.....	La	8	A	.....
Sol	5	G	.....	Sol	7	G$\sharp$	.....	Sol	7	G	.....
Fa	4	F	.....	Fa	6	F$\sharp$	.....	Fa	6	F	.....
Mi	3	E	.....	Mi	5	E	.....	Mi	5	E	.....
Re	2	D	.....	Re	4	D	.....	Re	4	D	.....
Do	1	C	.....	Do	3	C	.....	Do	3	C	.....
.....	.....	.....	.....	Si	2	B	.....	Si	2	B	.....
.....	.....	.....	.....	La	1	A	.....	La	1	A	.....

No. 1, in Diagram 6, represents the ascending and descending major scale; No. 2, the ascending minor scale; and No. 3, the descending minor scale.

* In pluralising staffs is preferable to *res.*

There is another scale, called the semitonic, or chromatic. It is formed by dividing the whole tones of the diatonic scale into semitones, by five additional sounds. The chromatic scale may be illustrated by touching all the white and black keys of a pianoforte, in their consecutive order. (The chromatic scale is represented by No. 4, in Diagram 6.)

The sounds which compose the diatonic scale, as I have said, are named after the first seven letters of the alphabet. The five additional sounds, which, when added to the diatonic scale, divide it into semitones, are called *flats* or *sharps*, according as they receive the names of the notes immediately below, or of those immediately above them. Thus, the second note of the chromatic scale of *C*, is called *C sharp*, or *D flat*; the fourth is called *D sharp*, or *E flat*; the seventh, *F sharp*, or *G flat*; the ninth, *G sharp*, or *A flat*; and the eleventh, *A sharp*, or *B flat*. (See No. 4, in Diagram 6.)

When a note is to be sung, or played sharp, a character called a sharp ($\sharp$) is prefixed to it. When a note is to be sung or played flat, a character called a flat ($\flat$) is prefixed to it. Sharps and flats are generally placed at the beginning of a tune, or strain, immediately after the clef. They are then called the signature; because they serve to point out the key.

By *key* is meant a scale of sounds, to the first of which all the others bear a certain relation. This *first* note is called the *key-note* or *fundamental note*, or *tonic*. As each note of the diatonic scale of *C* (see No. 1), as well as its sharp and flat (see No. 4), may be assumed as a key-note of a series of seven, it follows that there are twenty-one *major*, and twenty-one *minor* keys. And as each note of the diatonic scale of *C*, as well as its sharp and flat, may also be assumed as a key-note of a *chromatic* series, it follows that there are twenty-one keys in the chromatic genus. These, added to the forty-two keys in the diatonic genus, make the whole number of keys in the musical system amount to sixty-three. Still, as there are but twelve notes, there can be but thirty-six scales; and even this number may be resolved into three—one *major*, one *minor*, and one *chromatic*; all the others are transpositions of the three primitive scales into different ranges of pitch.

The *speaking voice*, in good elocution, seldom rises higher than a fifth above the lowest note of its compass. Supposing the lowest note which can be made with a full intonation, to be *F*, the following scheme will show the relative pitch of keys, adapted to the expression of different kinds of sentiments.

KEYS OF THE SPEAKING VOICE. (Diagram 7.)

10	A	Vociferation.
9	G	
8	F	Very spirited declamation.
7	E	
6	D	.....
5	C	Spirited declamation.
4	B $\sharp$	Ordinary declamation.
3	A	Modest declamation.
		Ordinary narrative.
2	G	Dignified narrative.
		Sublime description.
1	F	Very solemn discourse.

{ Three millions of people,
armed in the holy cause of liberty,
and in such a country as we possess, &c.

My brave associates, &c.
Friends, Romans, countrymen, &c.
The tree of deepest root is found, &c.
He scarce had ceased, &c.
I had a dream which was not all a, &c.
Oh, when shall day dawn, &c.

We not unfrequently meet with individuals who always speak in the highest key of the natural voice, and we occasionally meet with some who even speak in the falsetto.

A high pitch, in speech, is unpleasant to a cultivated ear; and is totally inadequate to the correct expression of sentiments of respect, veneration, dignity, and sublimity.

LESSONS IN FRENCH.

(Continued from page 113.)

OF THE USE OF THE ARTICLE WITH
PROPER NAMES.

THE article being only introduced into the language to show that the noun which it precedes is considered by the mind in a definite point of view, it is clear that it should be dispensed with when the noun to be used is so definite in its nature as to leave no doubt as to the particular thing or individual which that noun is intended to represent; such is the case with proper names in general. Thus, in the following sentence, *God is great*, no sign is necessary to show what idea is represented by God, because with us French there is but one God; *Napoleon was a great general*—there has been with us but one Napoleon; therefore the article *the* is not required to show what Napoleon we speak of. But this rule is subject to many exceptions, and we will examine them separately.

NAMES OF COUNTRIES USED WITHOUT
A PREPOSITION.

Names of countries always take the article when used without being preceded by a preposition; as,

France is a beautiful country, *La France est un beau pays,*

because, in such case, the mind referring to the whole extent of the country, the article is necessary to indicate this particular circumstance as it shows it in common nouns.

Exception.—Countries which have the same names as their capitals, take no article, because, by a singular disposition of their mind, the French never think, when speaking of a city, how small or large that city is: it is for them but a black spot on the map, having such a name, and, by analogy, when this name of city is applied to a country, it retains its peculiarity, and therefore requires no article; thus we say:

Naples is a delightful country, *Naples est un pays délicieux.*

Napies is a very fine city, *Naples est une très belle ville.*

NAMES OF COUNTRIES PRECEDED BY A
PREPOSITION.

Whenever a name of a country is pre-

ceded by a preposition, it must be considered whether that name is used in reference to the extent of its signification or not, the extent of the signification of a name of country being that of its territory; in the first place it takes the article, in the other it does not: thus, if we wish to say, *Which do you prefer, the wines of France or Portugal?* it is evident that the mind does not refer to the extent of these two countries; for no man has ever tasted the whole of the wines which grow in these two countries; and, besides, the greatest part of these wines, not being fit to drink, they cannot be alluded to as a whole in such a question. *France* and *Portugal* are then only used as adjectives to designate the kind of wine spoken of, showing these wines as coming from the countries thus designated, and not from Germany, Italy, or any other country, without any reference to the extent of the territories of the former countries. The above sentence should, then, be expressed by, *Que préférez-vous, les vins de France ou ceux de Portugal?*

But in the following sentence:

The wines of France pay a tax of two millions to the government,

the mind alludes to the whole extent of France; the proper name *France* is no longer used adjectively; it is not intended to distinguish the wines of France from those of Spain or any other country, as in the preceding sentence, and it assumes the character of definiteness, which requires the use of the article *the*, and we say:

Les vins de la France paient une taxe de deux millions de livres au gouvernement.

If I wish to say that the Queen of England is expected at Paris; although the queen spoken of is certainly the queen of the whole country called England, the mind does not allude to the extent of that territory; it only refers to the queen as ruling over a country called England, and not France or Germany, without any allusion to the extent of that country: it is then used adjectively, and requires no article. Thus we say,

La Reine d'Angleterre est attendue à Paris.

In the following sentence,

I have travelled in England, France, and Germany,

the person who speaks does not refer to

the extent of these countries; he does not mean to say that he has been all over Germany, France, or England; he only wishes to express that he has been in some parts of each; they are then used as mere proper names, without any reference to the extent of their territories; and this view of the mind not requiring that the article should be used before them, *in* is then rendered by the preposition *en*, which always conveys the idea of an indefinite character. Here it must be well understood, that it is not because *in* is expressed by *en* that the article is not used before the following noun, but it is the absence of the article which requires *in* to be thus rendered in French; the preceding sentence is then thus expressed:

J'ai voyagé en Angleterre, en France, et en Allemagne.

The preposition *en*, *in*, as well as *de*, *of*, *à*, *to*, being always repeated before each noun.

But if the person who speaks wished to express that he has been all over England, France, and Germany, these names of countries being then understood in reference to the whole extent of their signification, that is to say, of their territories, they should be preceded by the article *the* and *in*, expressed by *dans*, as:

J'ai voyagé dans toute la France, l'Allemagne, et l'Angleterre.

To this general rule which requires that the article should not be used before names of countries, unless employed in reference to the extent of their territories, there is an exception, which is purely idiomatical, and based upon no principle; it is a mere fact which habit has consecrated, and such as are found in every language and almost every branch of human knowledge. When speaking of coming from or going to far distant countries which the French seldom visit, the article *the* is used with the prepositions *of*, *or from*, *de*, and *to*, *à*, and *dans*, *in*, as,

I will go to Peru, when	<i>J'irai au (to the) Pérou</i>
you will return from	<i>quand vous reviendrez de la (from the)</i>
China.	<i>Chine.</i>

The two names of countries used in this sentence, are not certainly understood by the mind in reference to the extent of their signification, for a man cannot return at once from or go to a whole country; but this discrepancy should be admitted, not-

withstanding its being in opposition to the general principle, because usage has consecrated it. The following list contains the names of those countries to which this exception should be applied.

When speaking of coming or returning from the following countries we say:

I return from, or this comes from	<i>Je reviens, or cela vient</i>
the India, or the Indies	<i>de l'Inde, or des Indes.</i>
the Indostan	<i>de l'Indostan.</i>
the Malabar	<i>du Malabar.</i>
the China	<i>de la Chine.</i>
the Nigritia	<i>de la Nigritie.</i>
the Guinea	<i>de la Guinée.</i>
the Congo	<i>du Congo.</i>
the Cochin China	<i>de la Cochinchine.</i>
the Peru	<i>du Pérou.</i>
the Tonquin.	<i>du Tonquin.</i>
the Thibet	<i>du Thibet.</i>
the Japan	<i>du Japon.</i>
the Abyssinia	<i>de l'Abyssinie.</i>
the Mogul	<i>du Mogol.</i>
the Monopotama	<i>du Monomotapa.</i>
the Caffraria	<i>de la Cafrerie.</i>
the Zanguebar	<i>du Zanguebar.</i>
the Acadia	<i>de l'Acadie.</i>
the Guiana	<i>de la Guiane.</i>
the Barbadoes	<i>du Barbade.</i>
the Jamaica	<i>de la Jamaïque.</i>
the Martinico	<i>de la Martinique.</i>
the Guadaloupe	<i>de la Guadaloupe.</i>
the Havana	<i>de la Havane.</i>
the Black Sea	<i>du Pont-Euxin.</i>
the Phillippine Islands	<i>des Philippines.</i>
the Molucca Islands	<i>des Moluques.</i>
the Antilles Islands	<i>des Antilles.</i>
the East	<i>du Levant.</i>
the Spitzberg	<i>du Spitzberg.</i>
the Greenland	<i>du Gröenland.</i>
the Mexico	<i>du Mexique.</i>
the Paraguay	<i>du Paraguay.</i>
the Chili	<i>du Chili.</i>
the Brazil	<i>du Brésil.</i>
the Canada	<i>du Canada.</i>

Besides these names of countries, the article, with the preposition *of*, *or from*, *de*, is also used with a great number of names of provinces; such as, Virginia, Maryland, &c., &c., Picardy, Anjou, &c., &c.; but usage here is the only rule, and time and practice are the only means that can afford a foreigner the facility of overcoming this difficulty.

When speaking of going to a far distant country, the preposition *to*, *à*, and the article are used before the following nouns:

I am going to	<i>Je vais</i>
the Indias (plural)	<i>aux Indes.</i>
the Malabar	<i>au Malabar.</i>
the China	<i>à la Chine.</i>
the Congo	<i>ou Congo.</i>
the Cochin China	<i>à la Cochinchine.</i>
the Peru	<i>au Pérou.</i>
the Tonquin	<i>au Tonquin.</i>
the Thibet	<i>au Thibet.</i>

the Japan	<i>au Japon.</i>
the Monopotama.	<i>au Monomotapa.</i>
the Zanguebar	<i>au Zanguebar.</i>
the Guiana	<i>à la Guiane.</i>
the Barbadoes	<i>à la Barbade.</i>
the Jamaica	<i>à la Jamaïque.</i>
the Martinico	<i>à la Martinique.</i>
the Guadeloupe	<i>à la Guadeloupe.</i>
the Havana	<i>à la Havane.</i>
the Black Sea	<i>au Pont-Euxin.</i>
the Philippine Islands	<i>aux Philippines.</i>
the Molucca Islands	<i>aux Moluques.</i>
the Antille Islands	<i>aux Antilles.</i>
the Spitzberg	<i>au Spitzberg.</i>
the Greenland	<i>au Gröenland.</i>
the Mexico	<i>au Mexique.</i>
the Paraguay	<i>au Paraguay.</i>
the Chili	<i>au Chili.</i>
the Brazil	<i>au Brésil.</i>
the Canada	<i>au Canada.</i>

The following names of countries take the preposition *in*, *dans*, and the article; as,

I am going to	<i>Je vais</i>
the India (singular)	<i>dans l'Inde.</i>
the Nigritia	<i>dans la Nigritie.</i>
the Abyssinia	<i>dans l'Abyssinie.</i>
the Caffraria	<i>dans la Cafrerie.</i>
the Acadia	<i>dans l'Acadie.</i>
the East	<i>dans le Levant.</i>

There are many names of provinces which grammatically take the preposition *in*, expressed by *en* without the article, or *dans* with the article. But as there are no fixed rules about them, we still refer to usage, —which is the only guide in this matter.

From what has just been said, we may deduce the following rules:

(1.) When speaking of a country we come from, if that country is far distant and but little visited by the French, the preposition *from*, *de*, is used with the article before the noun designating that country.

(2.) If, on the contrary, the country is not far distant, as England, Italy, &c., the preposition *from* is rendered by *de* alone.

(3.) If we are speaking of going to a far distant country, *to* is expressed in most cases by the preposition *à* and the article, and in a few instances by *dans* and the article.

(4.) If the country we go to is not a far distant one, *to* is rendered by *en*, and no article is used; as,

I come from Peru and Mexico.	<i>Je viens du Pérou et du Mexique.</i>
I return from England and Russia.	<i>Je reviens d'Angleterre et de Russie.</i>
I am going to Brazil and Canada.	<i>Je vais au Brésil et au Canada.</i>
I am going to Nigritia and Abyssinia.	<i>Je vais dans la Nigritie et dans l'Abyssinie.</i>
I will go to England and Spain.	<i>J'irai en Angleterre et en Espagne.</i>

EXTREME SMALLNESS OF CERTAIN OBJECTS.

It was exceedingly well remarked by a very great man, that a mite is, in every way as wonderful a creation as an elephant. We are all apt to be more struck by the immense than by the minute. We look with a feeling of mingled awe and astonishment upon the mighty and the magnificent in Nature. The mountains, whose tops are hidden among the clouds; the cataracts, whose roar of waters resembles the loud thunders of the sky; the huge whale rolling his vast bulk in clumsy sportiveness upon the waves; or the enormous form of the colossal elephant, seizes at once upon our attention and upon our admiration. We cannot, if we would, withhold our attention or restrain our wonder. We feel our own littleness the more strongly by contrasting it with the immensity of other creatures; and we readily entertain a sense of the sublimity and power of the Creator of such stupendous wonders.

But though, in the more minute objects of the creation, there is no less of wonderful wisdom of design, and skilfulness of execution, we are more inclined to pass them by without notice. We look down with contemptuous inattention upon them; and because they are less than ourselves, we consider them less wonderful. This course, common as it is, is not more common than it is incorrect. If there be any difference between the marvellousness of a mite and that of a mammoth, sound reasoning would adjudge the palm rather to the former than to the latter. If we may venture to illustrate the subject of the creation of God by speaking of the work of man's hands, it may be sufficient to observe, that it is in the smaller and finer works of art that the greater skilfulness of the artificer is displayed. The larger, and, of course, rougher and ruder kinds of work, require considerably less finish and delicacy of execution than smaller ones. Defects and coarsenesses which, in the former, are imperceptible, are, in the latter, so conspicuous as to render the whole work imperfect and valueless. So it is in trifles, which frequently educe the most important results.



"THE stormy March is come at last,
 With wind, and cloud, and changing skies;
 I hear the rushing of the blast,
 That through the snowy valley flies.
 Ah! passing few are they who speak,
 Wild stormy month! in praise of thee;
 Yet, though thy winds are loud and bleak,
 Thou art a welcome month to me
 For thou to northern lauds again,
 The glad and glorious sun dost bring;
 And thou hast join'd the gentle train,
 And wear'st the gentle name of Spring."
 BRYANT.

HARK! how the wind is moaning and
 whistling through yon clump of trees that
 bend beneath its force; see the clouds

driven along the ethereal arch, and observe
 the smoke from the cottage chimney, now
 tossed on high, now whirled around, and
 then beaten below upon the dewy meads.
 Hark! the noise increases, and fearful
 gusts of wind shake the very house, and
 seem as if about to tear up the young
 trees by the roots. 'Tis blustering March
 chasing away shivering February, thus
 proving the truth of the old proverb, that
 "March comes in like a lion and goes out
 like a lamb." Yes! he blusters himself
 into our company; yet, rude as he appears
 to be upon making his first acquaintance

we love the kindly promises of calm skies, gilded showers, sprouting trees, budding flowers, and all the loveliness of coming spring, with which he entices us and wins our esteem.

The month was named by Romulus, in honour of his father Mars, the heathen God of War, and was formerly the first month of the year, which then only consisted of ten months. It had thirty-one days assigned it as its just share of the year. Numa Pompilius having added the two months of January and February, it became the third month, as at present, and continued so until the Christian Church adopted the season of Easter as the commencement of the year. In 1564 Charles IX. of France issued an edict which changed this plan, and ordered that the year should henceforth commence on the 1st of January. This reform was somewhat tardily adopted; however, we find the Scotch following the example in 1599, but the English continued to make the 25th of March the New-year's day until 1752.

The Romans considered that Minerva, the Goddess of Wisdom, had the especial patronage of this month, notwithstanding the relationship existing between Mars and Romulus. This people also regarded the month as an unlucky one for the celebration of marriages.

"The Saxons," says Verstegan, "called the month *Rhede* or *Rethe-Monath*, to denote its general boisterousness of character. *Rhede* signifying, in their interpretation, *rough* or *rugged*, many antiquarians contend that the month, having been dedicated to the idol *Rheda* before the conversion of the Saxons to Christianity, that the etymology of it thus given is more correct. The name was afterwards changed to *Lenet-Monat*, or length month, because in this month the length of the day begins to exceed that of the night. It has been said that *Lenet* signifies spring, and that therefore it was called spring month. As our Saxon ancestors observed the custom of fasting after they embraced Christianity, and as the period of the observance of this custom usually fell in the *Lenet-Monat*, it was called the *Lenet* fast, and by corruption the word *Lenet* became converted into *Lent*.

The synonymes of the month are some-

what curious, being *Martius* in Latin, *Mars* in French, *Marzo* in Italian, and *Marco* in Portuguese.

The allegorical representation of the month is a young man, of a tawny colour and fierce aspect, with a helmet on his head, being intended for Mars, the God of War. He is not armed in any other manner, being naked; in his right hand he holds a bunch of almond-blossoms, the hand resting upon a spade—which alludes to the preparation of the ground by the husbandman—and hanging upon the same arm is a basket of seeds. His left hand rests upon a ram; typical of the sign of *Aries*, or the ram, because the sun enters that constellation on the 20th of the month, when Spring commences. The poet, Spencer, represents the warlike Mars as riding on a ram, for he says:

"Sturdy March, with brows full sternly bent,
And armed strongly, rode upon a ram,
The same which over Hellespontus swam;
Yet in his hand a spade he also hent,
And in a bag all sorts of seeds, ysame,
Which on the earth he strewed as he went."

There are some proverbs relating to the month which are based upon its character. Thus it is sometimes said, that "a bushel of March dust is worth a king's ransom;" and, "a dry March never begs its bread." Both these proverbs signify that a dry March is favourable to the agriculturist and gardener; and this is borne out by another proverb, which says, that "March grass never did good;" hence we infer that a wet March, which would be necessary for the grass to grow so early, is prejudicial to the farmer and florist.

Our calendar contains many days of observance in March, which we shall at once proceed to describe.

THE FIRST DAY is called ST. DAVID'S DAY. *St. David* was descended from the royal family of the Britons, being uncle to King Arthur. He was educated in the celebrated monastery of Bangor, and was always intended for a priest. After some time he left his retirement in the Isle of Wight to preach to his countrymen. About the year 577, after much entreaty, he accepted the archbishopric of Caerleon, but removed the see to Menevia, a city in Pembrokeshire, on account of its retired position, and, perhaps, because he had already founded twelve convents there,

which were governed with great severity. In return for the many favours he bestowed upon the place, it was afterwards called St. David's, a name it still retains. Having lived to the good old age of 146 years, he died A. D. 642; and was henceforth adopted as the tutelary saint of the Welsh, who always wear leeks in their hats upon this day, as emblems of their nationality.

The custom of Welshmen wearing leeks in their hats or caps on *St. David's day* is said to owe its origin to their having gained a great victory over the Saxons, from whom they distinguished themselves by wearing leeks during the battle. Many other opinions are advanced to account for the custom, but they differ materially as regards the date of the introduction of the custom, and, as the above is more generally stated, we prefer giving it, notwithstanding that Sir S. Meyrick and others differ from it.

On this day, in 1553, François Rabelais, the celebrated French writer, who was born in 1483, at Chinon, in Touraine, died at Meudon.

THE SECOND DAY is dedicated to *St. Chad*, who was an English bishop. He was educated at the monastery of Lindisfarne, and was fifth bishop of the Mercians and third bishop of Lichfield, where he died in 673, and was buried with great pomp in the cathedral, his shrine costing upwards of £2,000 for decorations.

In 1787 Solomon Gesner, the painter and poet, author of *Tod Abels* ("The Death of Abel"), which he wrote in prose, died at Zurich in the 58th year of his age. His first publication was a few pastoral poems, "*Idyllen*," which, though much admired at the time, is now regarded as a tame production. In 1835 the Emperor of Austria, Francis I., died, in his 67th year; and in 1840 the treaty of commerce between Turkey and Spain was completed.

THE THIRD DAY. In 1605, Edmund Waller, the celebrated English poet, was born, at Coleshill, in Hertford; and on the same day, in 1651, Thomas Otway, the eminent dramatist, was born, at Trotten, in Sussex. Otway was celebrated for his wit, which gained the patronage of the Earl of Plymouth for him. Among his many productions we may mention "The

Orphan," performed in 1680, and "Venice Preserved," exhibited in 1682.

THE FOURTH DAY. In 1192 Salah-deen, commonly called Saladin, the famous Sultan of Egypt and Syria, against whom Richard Cœur de Lion led the Crusaders, died at Damascus, after twelve days' illness, aged 57 lunar years. In 1778 died Dr. Thomas Augustine Arne, the celebrated composer of the oratorios "Abel" and "Judith," and many operas, glees, and songs, among which may be mentioned "Rule Britannia," and "Come, Shepherds, we'll follow the Hearse." He was buried in St. Paul's church, Covent-garden.

THE FIFTH DAY.—On this day, in 1534, died Antonio Allegri, surnamed Corregio from the place of his birth, which is said to have taken place either towards the end of 1493 or commencement of 1494. He was celebrated as a painter, and formed a style of his own, remarkable for gracefulness of design; boldness, variety, and power of colouring, combined with richness; and he is also famous for his *chiaroscuro*. On this day, in 1826, Alessandro Volta, the celebrated professor of natural philosophy in the University of Pavia, died at Como. He invented the electrical pistol, the hydrogen lamp, and many other philosophical instruments, in addition to the metallic pile, called after him the Voltaic pile.

THE SIXTH DAY.—In 1474 Michel Buonarroti Angelo, was born, and in 1844 Francis Nicholson, the water-colour painter, died at the age of 91.

THE SEVENTH DAY.—In 1014 Canute was proclaimed King of England; and in 1846 a substance like manna fell in large quantities in Anatolia.

THE EIGHTH DAY.—In 1814 the late Duke of Wellington took Bordeaux; and in 1844 Karl Johann (Bernadotte), King of Sweden, died at the age of 80.

THE NINTH DAY.—In 1825, Mrs. Barbauld, the authoress, died in the eighty-second year of her age; and in 1844 Sir Henry Hallford, the celebrated physician, also died.

THE TENTH DAY.—In 1748 was born John Playfair, the celebrated mathematician, at Benvie in Forfarshire. Lord Bute, the distinguished senator who formed an administration after the retirement of Mr.

Pitt from the cabinet, had the merit of being a liberal patron of men of genius, both in literature and the arts. Among others, Dr. Johnson, and Home, the author of the tragedy of "Douglas," were indebted to him, the one for a pension, the other for a place. The architects George and Robert Adams, and Joshua Kirby, were all employed and munificently encouraged by him. He died at his house in South Audley-street, London, March 10, 1792.

THE ELEVENTH DAY.—In 1554 Torquato Tasso, son of Bernardo Tasso, was born at Sorrento. His fame as a poet was based upon his "*Gerusalemme Liberata*," which has been translated into most European languages.

THE TWELFTH DAY is dedicated to *St. Gregory*, surnamed the Great, who was born about the year 540. He was consecrated Pope about 590. He converted the English, being assisted by Augustine, a monk, who was in Kent, at the court of King Ethelbert. It is said that Pope Gregory, having seen some English captives exposed for sale at Rome, before he was elevated to the papal chair, inquired their country, and was answered that they were English pagans, upon which he replied, "*Non Angli, sed angeli fuerint si essent Christiani*," (not English, but angels, if they were Christians); and from that time he projected the conversion of the English nation, which he effected. In 1840, Lord Ellenborough introduced a bill for the encouragement of vaccination.

THE THIRTEENTH DAY.—On this day, in 1781, William Herschel discovered Uranus (*Georgium Sidus*), while engaged in examining some small stars in Gemini.

THE FOURTEENTH DAY.—In 1849, Shere Singh, Chuttur Singh, and the principal Sikh chiefs, surrendered with 16,000 of the Sikh army, forty-one guns and all their arms, to Major-General Gilbert, at Rawul-Pindee.

THE FIFTEENTH DAY.—In 1837, Bonvoisin, the painter, died at Paris, aged eighty-five; and in 1841, a meeting was held at Oxford at which the Vice-Chancellor, heads of houses, and Proctors of the University attended, and passed a resolution condemning the tracts commonly called Puseyite tracts. Julius Cæsar assassinated, B.C. 44.

"YOU WILL NEVER BE WORTH YOUR SALT."

A True Tale for Anybody, but for the Young in particular.

BY KAF.

WHEN I left school my handwriting was even worse than that of most school-boys; and the first thing that was given me to copy was so badly written that no person could read it, and I was equally puzzled myself. My master, for I was just apprenticed, told me never to write anything more, until it was properly written; and added, by way of a consolation, that he did not think I should ever be worth my salt.

Poor man! he is dead now; but the remembrance of his many good qualities will long be treasured up by others as well as myself. But to come to the point. He wrote what is called an excellent, legible hand, marked by certain peculiarities; but then, who is faultless?

"You will never be worth your salt," rang in my ears by day, and disturbed by dreams by night; and yet I could not write any better. How could it be expected, when no effort had been made?

I have said that my master wrote legibly and well; and it occurred to me one day, that by copying his handwriting several hours every day, my own would improve. I had tried all kinds of copy-books, but without success, and my forlorn hope was to master his style of writing. With this resolve, a stock of quill pens, the copy, and several sheets of paper, I sat down in my own room, after locking the door, to accomplish the task. For six hours my hand was solely employed in scribbling upon the paper, and dipping the pen in the ink; and at the end of that time my style had certainly improved, for the writing was legible.

"You will never be worth your salt," still rang in my ears; but now it was not so frequently repeated as before. Hope stimulated me; and in the evening, when all the family had retired to rest, I once more sat down to the task of improving my writing. Hour after hour passed away, and still my hand was busily employed in tracing the same words upon sheet after sheet of paper. The hour of

two struck by the clock of Old Lambeth Church, and reminded me that it was time my caligraphic exercises had ceased.

Day after day, and week after week, did I labour at the self-imposed task, until, at the end of three months, my handwriting was nearly equal to that of my master.

All my labours had been conducted in secret; and no one was aware that a thought about writing, or anything else, had entered my mind, until one day my master sent a message to me by the footman, desiring certain things to be executed.

"This is my time," said I; and therefore at once sat down, and wrote him an answer in my best style, imitating his own handwriting as closely as possible.

When he returned home, Mr. Matthews, for that was the name of my master, sent for me, and smiling blandly, said, "William, who wrote this answer from you?"

"Myself, sir," I replied with pride, and a great feeling of triumph.

"Umph! It is very well written, but the spelling is abominable."

Here was a plain fact that fell like a sledge-hammer upon my pride, and at once dashed it into a thousand atoms. What was to be done? I could never work again the same as at my writing; that was impossible,—nay, more, I would not, that I would not.

"You will never be worth your salt," rang in my ears again. My resolution was formed at once; and two hours afterwards, if any person had peeped into my room, they would have found me hard at work learning to spell the first twenty words in "Maunder's Treasury of Knowledge."

Day after day, week after week, and month after month, I laboured in secret and with satisfaction to myself; for my studies were progressing favourably, and I had worked through Maunder three times; "Once more will do," said I, and commenced the task for the fourth time.

One morning, soon after breakfast, Mr. Matthews sent for me to his study, and after telling me to shut the door and be seated, said, "William, I have often thought about the improvement in your writing; who instructed you?"

"Not any person, sir."

"Then how did you learn, if you had not any instructor?"

"By copying your handwriting, and practising thus upon sheets of paper;



sometimes making the figure from right to left, and at other times from left to right."

"What was your object in making such figures?"

"To make my letters rounder and more legible, give greater freedom to my writing, and facility in the use of the pen. I discovered this method one day while attempting to form an O quickly; and it then occurred to me, that by practising my hand in this manner, I should overcome the cramped style of writing so prevalent with school boys.*

"What pens did you use?"

"Always quill pens; for I believe that my bad writing was owing to the use of steel pens."

"Ah! I wish that every person would only follow your example, William; what a saving of time, money, and even life there would be, for bad writing is a disgrace to any properly educated person; bad spelling is even more pardonable than bad writing."

"Indeed, sir, I always thought that the latter was held in greater contempt than the former."

"It is, generally, I admit; bad spelling at once betrays that the person is not well educated, even if the writing is good; but I have generally observed that bad writing is frequently used to cover bad spelling."

"Yes, sir; but now I *can* spell properly,

* Several persons have improved their handwriting by adopting this plan at my request, and I am confident that *any* person who will *persevere* will be able to write a good legible style by pursuing this plan. It is worth trying.

for I have laboured through 'Maunder's Treasury of Knowledge,' four times."

"Then you are a prodigy, a very model of perseverance," said Mr. Matthews, "and the fruit of your labour is your reward."

"Yes, sir, and I shall always thank you for making me persevere in the task."

"Me?"

"Yes, sir; for I am certain that it would never have been undertaken if your remark had not always been ringing in my ears."

"What remark was that, William?"

"YOU WILL NEVER BE WORTH YOUR SALT."

ON THE ARTIFICIAL FORMATION OF MINERALS.

To penetrate the hidden processes of nature, whereby the gems and beautiful crystallized minerals we so frequently meet with imbedded in the cavities of rocks, are produced, has been the aim of many distinguished modern philosophers. But partial success has attended their endeavours, and, to my thinking, for one very good reason, viz., that when a crystalline mineral is not of igneous origin, but dependent upon aqueous, atmospheric, or molecular action or change, that time is an essential element in its production; a period compared with which, the life of man is of a verity but a "span long." By igneous action, various minerals have been synthetically obtained in the hearths of iron furnaces, of porcelain furnaces, and in the flame of the oxy-hydrogen blow-pipe; the usual condition being, as in the experiments of Edelmann, that the components of the minerals should be held in solution, or at any rate in suspension, by some solvent capable of volatilization at intense heats, qualifications especially possessed by borax and boracic acid. By such means, felspar, ruby, spinelle, and many aluminous minerals, have been obtained in a crystalline form. Some few may be obtained from their aqueous solutions, as various earthy or metallic carbonates, and others again by weak electrical action. This last natural force is that M. Becquerel has availed himself of, with much success, in his investigations on this subject. His experiments were commenced in 1845,

and his results have just been published, from which it appears that he has succeeded in obtaining crystallized hydrated oxide of zinc, and also crystallized protoxide of lead, by suffering galena (intermixed with blende?) to act on strong and mixed solutions of common salt and sulphate of copper. By this reaction he has obtained, after the expiration of six to seven years, chloride of sodium in cubes, cubic octohedrons, and octohedrons; chloride of lead in cubic and also in acicular crystals; sulphate of lead in cuneiform octohedrons exactly resembling the Anglesea mineral; chlorosulphate of lead in acicular crystals; oxichloride of lead in very minute crystals, and amorphous sulphuret of copper; all which substances coated the lump of galena, giving it the appearance of a specimen from a natural mineral vein. By weak voltaic arrangements this physicist obtained the carbonate of lime and of lead in a crystalline form. These experiments seem to show that when one substance is slowly oxidized in solutions of others upon which the oxide formed will react, that various insoluble and soluble crystalline bodies result from this action; and also, that when several complicated double decompositions are induced of a very slow and feeble nature, that the result may be the formation of many different insoluble crystalline compounds, precisely similar to those we meet with in many minerals.

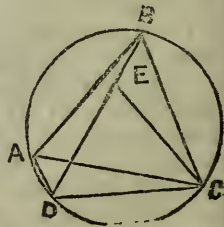
ANSWERS TO MATHEMATICAL PROBLEMS, PAGE 98.

1.

Put x^3 = the greatest number, and y = lesser, then by the question, $y^2 + x = x^3$ and $y^2 - x = y$. Now it is evident that $y^2 = y + x \pm x^3 - x \therefore y = x^3 - 2x$. Hence, $x^3 - x \mid \frac{1}{2} = x^3 - 2x$, from whence $x = 1.759$, and $\therefore 5.4425$ and 1.9192 are the numbers required.

2.

Let A B C be an equilateral triangle inscribed in the circle B C D A, and the lines drawn as required; then take DE = DC, and join CE, the triangle D C E is equilateral, and the triangle C B E equal in all respects to the triangle C A D, consequently D C (DE) + A D (BE) = B D.



NATURAL PHILOSOPHY.

SPECIFIC GRAVITY:—*continued from page 128.*

In the act of floating, the body is divided into two regions: one is immersed in the liquid and the rest is in the air. The part which is immersed under the surface of the liquid is *such as displaces a quantity of that liquid as is precisely equal in weight to the floating solid.* This may be proved experimentally. Fill a glass, A, with water until it runs off through the spout, *a*, then immerse in it a floating body, such as a wooden ball; the ball will displace a quantity of water, which, if it be collected in the receiver, B, and weighed, will be found precisely equal to the weight of the wood.

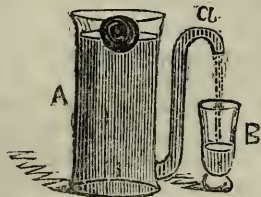


Fig. 76.

becomes wholly immersed.

In fluids of different densities any floating body sinks deeper in that which has the smallest density. It will be recollected that these are the principles which are involved in the action of hydrometers. They are also applied in the case of specific-gravity bulbs, which are small glass bulbs, with solid handles, adjusted by the maker, so as to be of different densities. When a number of these are put into a liquid, some will float and some will sink; but the one which remains suspended, neither floating nor sinking, has the same specific gravity as the liquid. That specific gravity is determined by the mark engraved on the bulb.

When a body floats on the surface of water it tends to take a position of stable equilibrium. The principles brought in operation here will be more fully described when we come to the study of the centre of gravity of bodies. For the present, it is sufficient to state, that stable equilibrium ensues when the centre of gravity of the floating solid is in the same vertical line as the centre of gravity of the portion of fluid displaced, and as respects position beneath it. These considerations are of great importance in the art of ship-building, and also in the right distribution of the cargo or ballast of a ship.

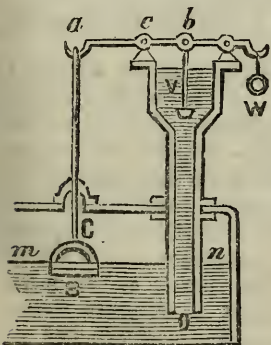


Fig. 77.

The principle of flotation is ingeniously applied in the ballcock, an instrument for keeping cisterns or boilers filled with a regulated amount of water. Thus, suppose that *m n*, Fig. 77, be the level of the water in the boiler of a steam-engine; on its surface let there float a body, B, attached by means of a rod, C, *a*, to a lever *a c b*, which works on the fulcrum *c*; on the other side of the lever, at *b*; let there be attached, by the rod *b V*, a valve, V, allowing water to flow into the boiler, through the feed-pipe, V O. Now, as the level of the water, *m n*, in the boiler lowers through evaporation, the float, B, sinks with it, and depresses the end, *a*, of the lever; but the end, *b*, rising, lifts the valve, V, and allows the water to go down the feed-pipe; and as the level again rises in the boiler the valve, V, again shuts. Instead of a piece of wood or hollow copper ball, a flat piece of stone, B, is commonly used; and to make it float it is counterpoised by a weight, W, on the opposite arm of the lever.

OF REST AND MOTION.—MECHANICS.

CHAPTER XV

MOTION AND REST.

Causes of Motion.—Classification of Forces.—Estimate of Forces.—Direction and Intensity.—Uniform and Variable Motions.—Initial and Final Velocities.—Direct, Rotatory, and Vibratory Motions.

ALL objects around us are necessarily in a condition either of motion or of rest. [Were there no motion in the universe it would be dead. It would be without the rising or setting of sun, or river-flows, or morning winds, or sound or light, or animal existence. To understand the nature and laws of the motions or changes which are going on around him, is to man of the greatest importance, as it enables him to adapt his actions to what is coming in futurity, and often to interfere so as to control and direct futurity for his special purposes.—*Dr. Arnott's Elements of Physics*, p. 45.] We shall soon find that matter has not of itself a predisposition for one or other of these states; and it is the business of natural philosophy to assign the particular causes which determine it to either in any special instance. A very superficial investigation soon puts us on our guard against deception. Things may appear in motion which are at rest, or at rest when in reality they are in motion. A passenger in a railroad-car sees the houses and trees in rapid motion, though he is well assured that this is a deception—a deception like that which occurs on a greater scale in the apparent revolution of the stars from east to west every night—the true motion not being in them, but in the earth, which is turning in the opposite direction on its axis.

If deceptions thus take place as respects the state of motion, the same holds good as respects the state of rest. On the surface of the earth even those objects which seem to us to be quite stationary are not so in reality. Motion is described in any particular case by referring to centre objects and certain standards of velocity. A man sitting on the deck of a sailing-ship has *common* motion with the ship; if walking on the deck, he has *relative* motion to the ship; but if he be walking towards the stern, just as fast as the ship advances, he is at rest relatively to the bottom or shore. A ship sailing against the tide, just as fast as the tide runs, has rest relatively both to the earth and water. *Absolute* motion is that which is relative to the whole universe, or to the space in which the universe exists. We have no means of ascertaining such; for although we know how fast our globe whirls upon its axis and round the sun; we have no measure of the motion of the sun himself—revolving, probably, round some more distant centre, and carrying all the planets along with him.

“Motion is called *rapid*, as that of lightning—*slow*, as that of the sun-dial shadow; both terms having reference to ordinary intermediate velocities. It is called *straight* or *rectilinear*, in the observed path of a falling body—*bent*, or *curvilinear*, in the track of a bullet shot obliquely—*accelerated*, in a stone falling to the earth—*retarded*, in a stone thrown upwards while rising to the point where it stops before again descending.”—*Dr. Arnott's Elements of Physics*, p. 46. Natural objects, as mountains and the various works of man, though they seem to maintain an unchangeable relation as respects position with all the world for centuries together, are but in a condition of *RELATIVE REST*. They are, of course, affected by the daily revolution of the earth on its axis, and accompany it in its annual movements round the sun. Indeed, as respects themselves, their parts are continually changing position. Whatever has been affected by the warmth of summer shrinks into smaller space through the cold of winter. Two objects which maintain their position toward each other are said to be at *relative* and *absolute rest*; but we make a wide distinction between this and *absolute rest*. All philosophy leads us to suppose that throughout the universe there is not a solitary particle which is in reality in the latter state.

Whenever an object, from a state of apparent rest, commences to move, a cause for

the motion may always be assigned. And inasmuch as such causes are of different kinds, they may be classified as primary or secondary motive powers. The primary motive powers are universal in their action. Such, for instance, as the general attractive force of matter or GRAVITY. The secondary are transient in their effects. The action of animals, of elastic springs, of gunpowder, are examples. Of the secondary forces, some are momentary and others more permanent, some giving rise to a blow or shock, and some to effects of a continued duration.

Forces may be compared together as respects their intensities by numbers or by lines. Thus one force may be five, ten, or a hundred times the intensity of another, and that relation be expressed by the appropriate figures. In the same manner, by lines drawn of appropriate length, we may exhibit the relation of forces; and that not only as respects their relative intensity, but also in other particulars. The *direction of motion* resulting from the application of a given force may always be represented by a straight line drawn from the point at which the motion commences toward the point to which the moving body is impelled. The point at which the force takes effect upon the body is termed the *point of application*; and the *direction of motion* is the path in which the body moves. To this special designations are given appropriate to the nature of the case, such as curvilinear, rectilinear, &c.

Moving bodies pass over their paths with different degrees of speed. One may pass through ten feet in a second of time, and another through a thousand in the same interval. We say, therefore, that they have different *velocities*. Such estimates of velocity are obviously obtained by comparing the spaces passed over in a given unit of time. The unit of time selected in natural philosophy is *one second*.

A moving body may be in a state of either uniform or variable motion. In the former case its velocity continually remains unchanged, and it passes over equal distances in equal times. In the latter its velocity undergoes alterations, and the spaces over which it passes in equal times are different. If the velocity is on the increase, it is spoken of as a *uniformly accelerated motion*. If on the decrease, as a *uniformly retarded motion*. In these cases we mean by the term *initial velocity* the velocity which the body had when it commenced moving, as measured by the space it would then have passed over in one second; and, by the *final velocity*, that which it possessed at the moment we are considering it measured in the same way. The flight of bomb-shells upward in the air is an instance of retarded motion; their descent downward of accelerated motion. The movement of the hands of a clock is an example of uniform motion.

There are motions of different kinds: 1st, direct; 2nd, rotatory; 3rd, vibratory.

1st. By direct motion we mean that in which all the parts of the whole body are advancing in the same direction with the same velocity.

2nd. By rotatory motion we imply that some parts of the body are going in opposite directions to others. The axis of rotation is an imaginary line, round which the parts of the body turn, it being itself at rest.

3rd. By vibratory movement we mean that the body which changes its place returns toward its original position with a motion in the opposite direction. Thus, the particles of water which form waves alternately rise and sink, and the pendulum of a clock beats backward and forward. These are examples of vibratory or oscillatory movement.

CHAPTER XVI.

OF THE COMPOSITION AND RESOLUTION OF FORCES.

Compound Motion.—Equilibrium.—Resultant.—The Parallelogram of Forces.—Case where there are more Forces than Two.—Parallel Forces.—Resolution of Forces.—Equilibrium of three Forces.—Curvilinear Motions.

WHEN several forces act simultaneously on a body so as to put it in motion, that motion is said to be compound.

In cases of compound motion, if the component or constituent forces all act in the

same direction, the resulting effect will be equal to the sum of all those forces taken together.

If the constituent forces act in opposite directions, the resulting effect will be equal to their difference, and its direction will be that of the greater force. Thus, if to a knot, a , Fig. 78, we attach several weights, b, c , by means of a string passing over a pulley, e , these weights will evidently tend to pull the knot from a to e . But if to the same knot we attach a weight, f , by a string passing over the pulley g , this tends to draw it in the opposite direction. When the weights on each side of the knot act conjointly, they tend to draw it opposite ways, and it moves in the direction of the greater force.

If two forces of equal intensity, but in opposite directions, act upon a given point, that point remains motionless, and the forces are said to be in *equilibrio*. When there are many forces acting upon a point in *equilibrio*, the sum of all those acting on one side must be equal to the sum of all the rest which act in the opposite direction.

By the *resultant* of forces we mean a single force which would represent in intensity and direction the conjoint action of those forces.

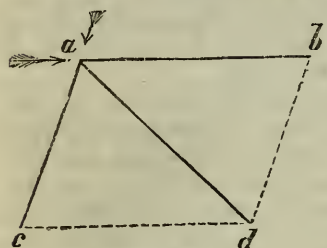


Fig. 79.

If the constituent forces neither act in the same nor in opposite directions, but at an angle to each other, their resultant can be found in the following manner:— Let a be the point on which the forces act; let one of them be represented in intensity and direction by the line ab , and the other likewise in intensity and direction by the line, ac . Draw the lines bd, cd , so as to complete the parallelogram, $abcd$; draw also the diagonal, ad . This diagonal will be the resultant of the two forces, and will, therefore, represent their conjoint action in intensity and direction.

The operation of pairs of forces upon a point is readily understood. Thus, 1st. On a point a , Fig. 80, let two forces, ab, ac , act. Complete the parallelogram $abcd$, and draw its diagonal, ad . This line will represent in intensity and direction the

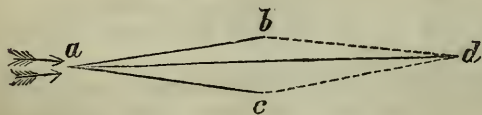


Fig. 80.



Fig. 81.

resultant force. 2nd. On a point, a , Fig. 81, let two forces again represented in intensity and direction by the lines, ab, ac , act. Complete the parallelogram, $abcd$, draw its diagonal, ad , which is the resultant, as before. Now, on comparing Fig. 80 with Fig. 81, it readily appears that the resultant of two forces is greater, as those forces act more nearly in the same direction, and less as those forces act more nearly in opposite directions.

Many popular illustrations of the parallelogram of forces might be cited. The following may, however, suffice. If a boat be rowed across a river when there is no current, it will pass in a straight line from bank to bank perpendicularly; but this will not take place if there is a current, for as the boat crosses, it is drifted by the stream, and makes the opposite bank at a point which is lower according as the stream is more rapid. It moves in a diagonal direction.

On the same principles we can determine the common resultant of many forces acting on a point. Two of the forces are first taken and their resultant found. This

resultant is combined with the third force, and a second resultant found. This again is combined with the fourth force, and so on, until the forces are exhausted. The final resultant represents the conjoint action of all.

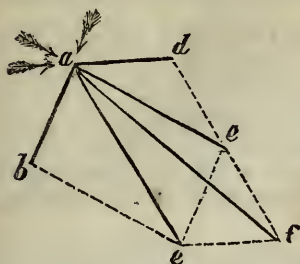


Fig. 82.

Thus, let there be three forces applied to the point, a , represented in intensity and direction by the lines, $a b$, $a c$, $a d$, Fig. 82, respectively; if $a b$ and $a c$ be combined, they give as their resultant, $a e$, and if this resultant, $a e$, be combined with the third force, $a d$, it yields the resultant, $a f$, which, therefore, represents the common action of all three forces.

The resultant of two parallel forces applied to a line, and on the same side of it, is equal to their sum and parallel to their direction. Thus the forces, $a b$, $a' b'$, applied to the line $a a'$, give a resultant, $p r$, parallel to their common direction and equal to their sum. (Fig. 83.)

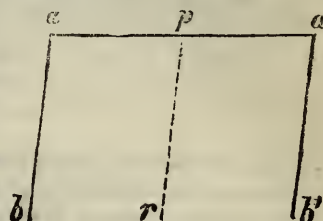


Fig. 83.

But when parallel forces are applied on opposite sides of a line, the resultant is equal to their difference, and its direction is parallel to theirs. In this, as also in the foregoing case, the point at which the resultant acts is at a distance from the points at which the two forces act, inversely proportional to their intensities. In the foregoing case this point falls between the directions of the two forces, and in the latter on the outside of the direction of the greater force.

The parallelogram of forces not only serves to effect the composition of several forces, but also the resolution of any given force; that is, to assign several forces which in their intensities and directions shall be equivalent to it. Thus, let $a f$, Fig. 84, be the given force; by making it the diagonal of a parallelogram it may be resolved into its components, $a d$, $a e$; in the same manner, $a e$ may be resolved into its components, $a c$, $a b$. Thus, therefore, the original force is resolved into three components, $a b$, $a c$, $a d$.

Upon similar principles it may be readily proved that two forces acting at any angle upon a point can never maintain that point in equilibrio; but three forces may; and in this instance, they will be represented in intensity and direction by the three sides of a triangle, perpendicular to their respective directions. If two forces act upon a point in the direction of and in magnitude proportional to the sides of a parallelogram, that point will be kept in equilibrio by a third force opposed to them in the direction of the diagonal and proportional to it. On the table, $a d$, Fig. 85, place a circular piece of paper, on which there is drawn any triangle, $a b c$, c coinciding with the centre of the table; and let us suppose that the sides of this triangle are, as shown in the figure, in the proportion to one another, as 2 3 4; draw upon the paper, $c e$, parallel to $a b$, and prolong $a c$ to d . Take three strings, making a knot at the point, c , and by means of the movable pulleys, $t t t$, stretch the strings over the lines, $c b$, $c d$, $c e$; at the end of $c d$, suspend a weight of four pounds, at the end of $c e$ one of three pounds, and at the end of $c b$ one of two pounds. The knot will remain in equilibrio, proving therefore, the proposition.

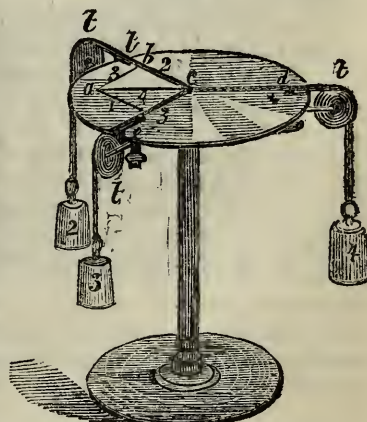


Fig. 85.

In the composition of forces power must always be lost. Thus, in this experiment, we see that a weight of three pounds and one of two pounds equipoise a weight of four pounds only.

If of two forces acting upon a point, one is momentary and the other constant, the point may move in a curve. Thus, if in Fig. 86, a shot be projected obliquely upward from a gun, it is under the action of two forces—the momentary force of the explosion of the gunpowder, and the constant effect of the attraction of the earth. It describes, therefore, a curvilinear path, $a b c$, the direction of which continually declines towards the direction of the constant force.

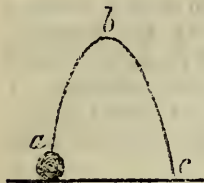


Fig. 86.

It is only when a force acts in a direction perpendicular to a body that its full effect is obtained. This is easily proved by resolving an oblique force into two others, one of which is perpendicular, and the other parallel to the side of the body acted upon. This latter force is, of course, lost.

CHAPTER XVII.

INERTIA.

Inertia a Property of Matter.—Indifference to Motion and Rest.—Moving Masses are Motive Powers.—Determination of the Quantity of Motion.—Momentum.—Action and Reaction.—Newton's Laws of Motion.—Bohnenberger's Machine.

ALL bodies have a tendency to maintain their present condition, whether it be of motion or rest. It is only by the exertion of force that that condition can be changed. A mass of any kind, when at rest, resists the application of force to put it in motion, and when in motion resists any attempt to bring it to rest. This property is termed INERTIA. ["It is, therefore, clear, that the action exercised upon the condition of motion of a body must depend, on the one hand, upon the intensity of the force, and, on the other, upon the degree of inertia in the body.

"The larger the quantity of matter—that is to say, the greater the mass is on which a force acts—so much the greater will be the resistance it offers; and we judge of the mass of a body by the amount of resistance which it can oppose by its inertia to an accelerating or retarding force."—*Professor Müller on Physics and Meteorology, Lecture 1.*]

It is illustrated by many familiar instances: thus, loaded carriages require the exertion of far more force to put them in motion than is subsequently required to keep them going, and a train of railroad cars will run for a great distance after the locomotive is detached.

Universal experience shows that inanimate bodies have no power to produce spontaneous changes in their condition. They are wholly inactive. Even when in motion they exhibit no tendency whatever to alter their state. Thus, the earth rotates on its axis at the same rate which it did thousands of years ago, and the planetary bodies pursue their orbits with an unchangeable velocity. A moving mass can neither increase nor diminish its rate of speed, for if it could do the former it must necessarily have the power spontaneously to put itself in motion if it were in a condition of rest. Nor can such a mass, if in motion, change the direction of its movement any more than it can change its velocity. Such a change of direction would imply the operation of some innate force, which of itself could have put the mass in movement.

Whenever, therefore, we discover in a moving body changes in direction or changes in velocity, we at once impute them to the agency of acting forces, and not to any innate power of the moving body itself.

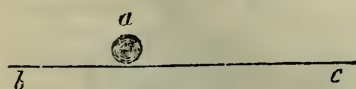


Fig. 87.

If an ivory ball, a , Fig. 87, be laid upon a sheet of paper, $b c$, on the table, and the paper suddenly pulled away, the ball does not accompany the movement but remains in the same place on the table.

A person jumping from a carriage in rapid motion falls down, because his body, still participating in the motion of the carriage, follows its direction after his feet have struck the earth.

By the **MASS** of a body we mean the quantity of matter contained in it—that is, the sum of all its particles. The mass of a body depends on its volume and density.

In consequence of their inertia, masses in motion are themselves motive powers. Such a mass impinging on a second tends to set it in motion. Thus, if a ball, *a*,

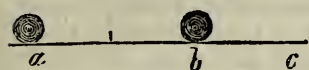


Fig. 88.

b, moving towards *c*, impinge upon a second ball, *b*, of equal weight, the two will move together toward *c*, with a velocity one half of that which *a* originally had. In this case, therefore, *a* has acted as a motive force upon *b*, and it is obvious that the intensity of this action must depend on the magnitude and velocity of *a*, increasing as they increase, and diminishing as they diminish. The ball, *a*, is said, therefore, to have a certain *momentum* or *moment*, which depends partly upon its mass and partly upon its velocity; and the *moments* of any two bodies may be compared by multiplying together the mass and velocity of each. Thus, if a body, *A*, has twice the mass of another, *B*, and moves with the same velocity, the momentum of *A* will be twice that of *B*; but if *A*, having twice the mass of *B*, has only half its velocity, the moments of the two will be equal.

It is upon this principle that heavy masses moving very slowly exert a great force, and that bodies comparatively light, moving with great speed, produce striking effects. The battering-rams of the ancients, which were heavy masses moving slowly, did not produce more powerful effects than cannon-shot, which, though comparatively light, move with prodigious speed.

From the foregoing considerations, it therefore appears that the amount of motion depends neither upon the mass alone nor the velocity alone. A certain mass, *A*, moving with a given velocity, has a certain momentum or quantity of motion. If to *A* a second equal mass, *B*, with a similar velocity be added, the two conjointly will, of course, possess double the momentum of the first—the mass has doubled, though the speed is the same, and therefore the quantity of motion has doubled. Again, if a certain mass, *A*, moves with a given speed, and a second one, *B*, moves with a double speed, it is obvious that this last will have twice the quantity of motion of the former. Here the masses are the same, but the velocities are different. The quantity of motion or momentum which a body possesses is, therefore, obtained by multiplying together the numbers which express its mass and its velocity.

Action and *Reaction* are always equal to each other. The resistance which a given body exhibits is equal to the effect of any force operating upon it. This equality of action and reaction may be shown by an apparatus represented in Fig. 89, in which two balls of clay or putty, *a* *b*, are suspended by strings so as to move over a graduated arc. If one of the balls be allowed to fall upon the other, through a given number of degrees, it will communicate to it a part of its motion, and the following facts may be observed: 1st. The bodies, after collision, move on together, and therefore have the same velocity. 2nd. The quantity of motion remains unchanged, the one having gained as much as the other has lost, so that if the two are equal they will have half the velocity after impact that the

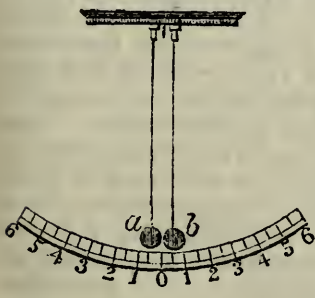


Fig. 89.

moving one had when alone. 3d. If equal, and moving in opposite directions with equal velocities, they will destroy each other's motions and come to rest. 4th. If unequal, and moving in opposite directions, they will come to rest when their velocities are inversely as their masses.

The following three propositions are called "Newton's laws of motion." They contain the results depending on inertia:—

I. Every body must persevere in its state of rest or of uniform motion in a straight line, unless it be compelled to change that state by forces impressed upon it.

II. Every change of motion must be proportional to the impressed force, and must be in the direction of that straight line in which the force is impressed.

III. Action must always be equal, and contrary to re-action, or the action of two bodies upon each other must be equal and directed to contrary sides.

As an example of the operation of inertia, and illustrating the invariability of position of the axis of the earth during its revolution, I here describe Bohnenberger's machine. It consists of three moveable rings, A A A, Fig. 90, placed at right angles to each other, and in the smallest ring there is a heavy metal ball, B, supported on an axis, which also bears a little roller, c. A thread, being wound round this roller and any particular position being given to the axis, by quickly pulling the thread the ball may be set in rapid rotation. It is now immaterial in what position the instrument is placed; its axis continually maintains the same direction, and the ring which supports it will resist a considerable pressure tending to displace it.

(To be continued.)

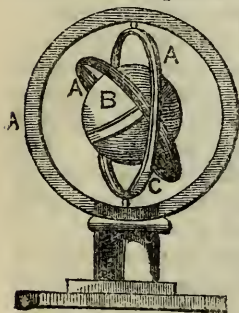


Fig. 90.

THE DAGUERREOTYPE PROCESS.—The first thing to be done is to prepare a plate, composed of copper, faced with a thin coating of pure silver, and polished with the greatest possible care. On the accuracy with which this is done depends the whole thing. The plate is then exposed to the vapour of iodine, and placed in the camera, a box containing a large convex lens, by which the light is condensed, and brought to a focus on a screen placed behind it. Having remained in the camera from ten seconds to a minute, or more, according to the brightness of the day, the plate is removed and exposed to the action of the vapour of mercury, by which the image formed on the silver is developed. In this state of the process the plate has a dark, purple colour, and the picture is readily destroyed by the light. The grand difficulty to be remedied, and for which Daguerre laboured so long, is to fix the image produced by the camera, and render it proof against the action of light. This is accomplished by washing the plate in a solution of the hypo-sulphate of soda, by which the iodine is expelled, and, finally, heating it in a bath of the chloride of gold, by which a thin transparent coating of gold is spread over the entire plate, and all change from the effects of light entirely prevented. The experiment requires care.

THE ESPIRITU SANTO.—This beautiful flower appears to be a description of lily, possessing a bulb root, long oval leaves, and a stock from three to four feet in length. The Espiritu Santo is one of those rare flowers that is said to be found only on one particular part of the isthmus, a short distance from Panama. It requires little earth for vegetation, growing among heaps of stones, with the fibres alone covered, the bulb being almost entirely exposed. The plant possesses little beauty beyond what is contained in the flower itself, which is of a most elegant and peculiar formation. The outward part, which is smaller than a pigeon's egg, resembles a curious shaped vase, on opening the lid of which the most perfect and beautiful *fac simile* of a dove is found within. The head is turned over its back, appearing as if it were about to take its farewell of earth and soar to some brighter region. No person can see this extraordinary flower for the first time without a deep feeling of wonder and admiration at the perfection and beauty displayed in its formation; and every succeeding time it is met with, the observer gazes upon it with increased admiration and curiosity. Of all the really beautiful plants or flowers we have ever seen, we recollect none so beautiful as the *Espiritu Santo*, or "Holy Spirit."

CHEMISTRY.

(Continued from page 131.)

Chemical Symbols of the Elements.—In the table of Elementary Bodies the “symbols” of the several elements will be found opposite to their names. The symbols are merely the first letter of each name, or the first two, when more than one element begins with the same letter; thus O stands for oxygen, and Os for Osmium; P stands for Phosphorus; Pl for Platinum, and Pd for Palladium. The second letter in all such cases is small, a capital letter being uniformly used for the first. The Latin names are invariably used for the abbreviation, and for this reason there are eleven symbols, unlike the common names of the elements they represent. Prof. Berzelius contrived the system of symbols now in use, and by a happy thought he made each symbol represent not merely the substance for which it stands, but one equivalent of each substance. Thus, O stands not for oxygen in general, but for one equivalent of that element; or, hydrogen being unity, for the number 8. O and 8 are therefore interchangeable expressions, while O^2 , O^3 , &c., represent 2×8 and 3×8 , or 16 and 24, according to the second law of chemical combination.

Compounds are represented by using merely the symbols, and sometimes uniting them by the sign of addition, (+). Thus water will be represented by HO or $H + O$, which means one equivalent of each element, $1 + 8 = 9$, which is the combining number of water. Protoxide of lead is thus written PbO, or $Pb + O$.

When more than one equivalent of an element is in combination, we then prefix a number expressing it, like an algebraic co-efficient (as 5O,) or the number may be applied above on the right (as O^5 ;) or below on the right, (as O_5 ;) each of these expressions means five equivalents of oxygen.

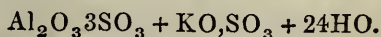
We can write nitric acid $N5O$, or NO^5 , or NO_5 , the latter being the usual mode; sometimes, but not often, the + or comma (,) is used between them, as $N + O_5$, or N,O_5 . Such expressions are called formulæ; thus the formula for sulphuric acid is SO_3 , or $S + O_3$, from which we know that the combining number of

sulphuric acid is $16 + 8_3$, or $16 + 24 = 40$. When two compounds unite to form a new body, the sign +, or (,) is used between them; thus sulphate of oxide of iron is written $FeO + SO_3$, or FeO,SO_3 . The small figures apply only to the letters to which they are attached; larger figures used before the compound, apply to the whole formula; thus, $3SO_3$ means three equivalents of sulphuric acid; but the sign + prevents the passage of this meaning beyond the sign. Thus $2FeO + SO_3$ means two equivalents of oxide of iron and one of sulphuric acid; in order to make the figures apply to both, we must write it $2(FeO + SO_3)$ or $2(FeO, SO_3)$.

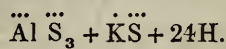
In chemical symbols, the oxygen, or element most nearly resembling it (*i. e.* the electro-negative element), is placed last; the base (or electro-positive element) being placed first. Thus we say SO_3 for dry sulphuric acid, and not O_3S . A compound of sulphuric acid (SO_3) and water contains 2 equivalents of water, only one of which is, however, chemically combined as a base with the acid. We can make this apparent to the reader in constructing the formula thus, $HO,SO_3 + HO$; the comma signifies a closer union than the +, and the first equivalent of water is in intimate union with the acid, forming a sulphate of water, while the second portion is combined with this sulphate. Compounds which contain water, like common sulphuric acid, nitric acid, and many mineral bodies, are termed *hydrous*.

The symbols are sometimes abbreviated still further, to simplify the expression of very complex combinations. This is done by expressing one equivalent of oxygen by a dot, two by two dots, &c.

Thus $\overset{\cdot\cdot}{S}$ signifies the same as SO_3 , (dry sulphuric acid). Common crystallized alum is written in full, thus,



We can conveniently condense this long expression; thus



The short line under the $\overset{\cdot\cdot}{Al}$ signifies two equivalents of the base. Sometimes the

double equivalent of base is denoted by

a black letter, thus, $\dot{\text{Al}}$, in place of the line beneath. In Berzelius's original symbols the short line is made through the type in the lower half. Sulphur is, in like manner, signified by a comma: thus, bisulphuret of iron, Fe,S_2 , may be

more shortly written $\ddot{\text{Fe}}$. The constant use of these symbolic expressions in the elementary chemistry will soon familiarize the learner with their use and meaning. They have contributed very much to the progress of the science, and are invaluable as a ready means of comparing as well as expressing the composition of compound bodies.

Chemical affinity. — Chemical affinity is the power which unites two or more unlike bodies to form a third substance, whose properties differ from those of its constituents. Chemical affinity or the capability of union, is not possessed alike by all bodies. Oxygen, as before stated, is the only element capable of forming chemical compounds with all other elements. Carbon can unite with oxygen, sulphur, hydrogen, and some other bodies, but no compound has been formed between it and gold, silver, fluorine, aluminium, iodine, bromine, &c. It is, therefore, said to have no affinity for these bodies, or no capability of union with them. The power of union among bodies, or affinity, is exceedingly different in degree, and is much affected by many circumstances. Thus a body A may unite with a body B, forming a third body AB; but if a body C had been present, A might have so much more affinity for C than it has for B, as to unite with it, forming AC, while B would remain unaffected. For example, sulphuric acid and soda will unite to form Glauber's salts, or sulphate of soda; but if soda and baryta had both been present, and sulphuric acid were added, only the sulphate of baryta (or heavy spar) would be formed, and the soda would remain disengaged, unless there was sulphuric acid enough to satisfy all the baryta and soda too. This is what is sometimes called elective affinity, as if the acid selected the baryta rather than the soda.

The more unlike, as a general thing,

any two bodies are in chemical properties, the stronger is their disposition to unite. The metals, as a class, have very little disposition to unite with each other, and when they do so it is not generally in chemical proportions. But they do unite with oxygen, chlorine, sulphur, &c., forming fixed and determinate compounds. The alkalies, potash and soda, form no proper compound with each other, and their alkaline properties are not altered by such union. Sulphuric and nitric acid may be mingled in any proportion, but no new compound is formed, and the mixture is still acid. But if the potash and soda be put with the nitric and sulphuric acid, separately, and in their combining proportions, the result will be two compound bodies, having neither acid nor alkaline properties. If the nitric acid is added to its equivalent of potash, we shall have saltpetre, or nitrate of potassa, while the sulphuric acid in like manner will unite with its equivalent of soda, forming sulphate of soda, or Glauber's salts.

Solution is the result of a feeble affinity, but one in which the properties of the dissolved body are unaltered; thus, sugar is dissolved in all proportions in water or alcohol, and a drop of the solution may be mingled in an ocean of water. Camphor is soluble in alcohol, in any proportion, but the addition of water to the solution will cause the camphor to be thrown down. Gum is soluble in water, but not in alcohol. We have already seen, that the solution of various salts in water would produce cold from the change of state in the body dissolved.

The circumstances which modify the action of affinity are numerous, some of which we may briefly notice. Chemical affinity existed only among unlike particles, and at insensible distances. Intimate contact among particles is, therefore, in the highest degree necessary to promote chemical union. Any circumstance which favours such contact will increase the activity of, or disposition to, chemical combination. Solution brings particles near together, and leaves them free to move among each other; substances in a state of solution have, therefore, an opportunity to unite, which they do not possess when solid. Hence the old maxim, "*Corpora non agunt nisi sint soluta.*"

Carbonate of soda and tartaric acid, for example, both in a dry state, will never unite; but the addition of water will at once, by dissolving them, bring about a union. Heat will often cause union to take place, being, in fact, a most powerful means of solution. Sand or silica will not unite with soda or potash by contact or aqueous solution, but if the mixture in proper proportions is strongly heated, union takes place and glass is formed. Sulphur will not unite with cold iron, but if the iron be heated to redness, or the sulphur melted, a vigorous union takes place, and a sulphuret of iron results.

Cohesion is strongly opposed to chemical union, or affinity, and any means which will overcome it will promote the union of the elements. Solution and heat both act by overcoming cohesion; and the fine mechanical division of a body, or pulverization, does the same.

Bodies in the nascent* state (as it is called) will often unite, when, under ordinary circumstances, no affinity is seen between them. Thus hydrogen and nitrogen gases, under ordinary circumstances, do not unite if mingled in the same vessel; but when these two gases are set free at the same time, from the decomposition of some organic matter, they readily unite, forming ammonia. The same is true of carbon under the same circumstances, which will then unite in a great variety of proportions with hydrogen and nitrogen, although no such union can be effected among these bodies separately.

The quantity of matter, as well as the order and condition in which substances may be presented to each other, often exerts an important influence on the power of affinity. Thus vapour of water, when passed through a gun-barrel heated to redness, will be decomposed, the oxygen uniting with the iron, while the hydrogen escapes at the other end of the tube. On the contrary, if hydrogen gas is passed over oxide of iron in a tube heated to redness, the oxygen of the oxide unites with the hydrogen, leaving metallic iron, while steam (formed from the union of the hydrogen with the oxygen from the iron) issues from the open end of the tube.

Numerous examples of this sort might be given, where the play of affinities seems to be determined by the preponderance of one sort of matter over another, or by the peculiar condition of the resulting compounds, as regards insolubility, or the power of vaporization.

The presence of a third body often causes a union, or the exertion of the force of affinity, when this third body takes no part in the changes which happen. Thus, oxygen and hydrogen gases may be mingled without any combination taking place between them, although a strong affinity exists. If, however, a portion of platinum in a state of very fine division (spongy platinum) be introduced into the mixture, union takes place, sometimes slowly, but more often with an explosion, the platinum being at the same time heated to redness from the rapid union of the gases which takes place in its pores. Advantage is taken of this fact in constructing the common instrument for lighting tapers by a stream of hydrogen falling on spongy platinum. No change is suffered in this case by the platinum, which seems to act by its presence only. Berzelius has proposed the term *catalysis*, from the Greek *kata*, by, and *luo*, to loosen, to express the peculiar power which some bodies possess of aiding chemical changes by their presence merely. We shall have occasion to refer to this subject again. The case of the platinum is much more intelligible than many other instances of contact-union, and decomposition of which chemistry offers examples, since it appears to act by its power of condensation, to bring the particles within combining distance.

Atomic Theory.—Atoms are the smallest conceivable state in which matter exists. As all ponderable matter is assumed to be formed by an aggregation of a series of these atoms, the interesting question at once arises, do the chemical equivalents or combining weights of the several elements express the relative weights of their atoms? Dr. Dalton first proposed the view now universally accepted, which assumes this to be the fact. All that has been said in this chapter on the combining weights of bodies, &c., has been the result of rigorous chemical investigation, and is

* From *nascens*, being born, or in the moment of formation.

capable of demonstrable proof. Dalton's hypothesis of the relative weights of ultimate atoms is only theoretical, but has been found to conform in a remarkable degree to the results of experience. We may feel some good degree of certainty in the belief that we know the actual relation of weight between the ultimate atoms or molecules of the elements. There is no doubt that the atom of sulphur is two times heavier than that of oxygen; but we know nothing of their actual weight.

We can now, perhaps, better understand why the equivalent numbers of bodies should always be multiples of each other. If the atom of oxygen be represented by eight (and we cannot conceive of an atom as being divided), then any compound containing more than one atom of oxygen, must have twice, thrice, or four times eight, and so on. On this view of atoms, all the four great laws of chemical combination receive a remarkable corroboration, as a little reflection will show. The atomic weight of a body is therefore as correct an expression as its equivalent weight, or combining proportion. We might easily illustrate this theory to the senses in a gross way, by a series of spheres so marked as to represent the several atoms of elementary bodies, the union of which would show the compound resulting from the union of atoms.

Specific Heat of Atoms.—Specific heat has already been explained. If in place of comparing equal weights of different bodies together, we take them in atomic proportions, we shall find the numbers representing the specific heat of lead, tin, zinc, copper, nickel, iron, platinum, sulphur, and mercury, to be identical; while tellurium, arsenic, silver, and gold, although equal to each other, will be twice that of the nine previous bodies, and iodine and phosphorus will be four times as much. The general conclusion drawn from these and other similar facts is, that the atoms of all simple substances have the same capacity for heat. The specific heat of a body would thus afford the means of fixing its atomic weight. There can be no doubt of the truth of this in numerous cases, but experiments are still wanting to show it to be universally true. Compound atoms have in some cases

been shown to have the same relations to heat as the simple. This is true of many of the carbonates, and some sulphates. A more minute discussion of the atomic theory would be out of place in this work.

CRYSTALLIZATION. Nature of Crystallization and Primary Forms of Crystals.—The forms of living nature, both animal and vegetable, are determined by the laws of vitality, and are generally bounded by curved lines and surfaces. Inorganic or lifeless matter is fashioned by a different law. Geometrical forms, bounded by straight lines and plane surfaces, take the place in the mineral kingdom, which the more complex results of the vital force occupy in the animal and vegetable world. The power which determines the forms of inorganic matter is called crystallization. A crystal is any inorganic solid, bounded by plane surfaces symmetrically arranged, and possessing a homogeneous structure. Crystallization is, then, to the inorganic world, what the power of vitality is to the organic; and viewed in this, its proper light, the science of crystallography rises from the low station of being only a branch of solid geometry, to occupy an exalted philosophical position. We see, therefore, the importance of devoting a brief space to this subject in considering the general principles of Chemical Philosophy.

The cohesive force in solids is only an exertion of crystalline forces, and in this sense no difference can be established between solidification and crystallization. The forms of matter resulting from solidification may not always be regular, but the power which binds together the molecules, is that of crystallization.

Circumstances influencing Crystallization.—Solution is one of the most important conditions necessary to crystallization. Most salts and other bodies are more soluble in hot than in cold water. A saturated hot solution will usually deposit crystals on cooling. Common alum and Glauber's salts are examples of this. Solution by heat or fusion also allows of crystallization, as is seen in the crystalline fracture of zinc and antimony. Sulphur crystallizes beautifully on cooling from fusion, and so do bismuth and some other substances. The slags of iron furnaces and scorïæ of volcanic districts

present numerous examples of minerals finely crystallized by fire. The glass, which cools slowly after long fusion, in the clay fire-pots of our glass-houses, has often beautiful star-formed opaque white crystals found in it, and the whole mass of the glass sometimes becomes crystalline and opaque. Blows, and long continued vibration, produce a change of molecular arrangement in masses of solid iron and other bodies, resulting often in the formation of broad crystalline plates. Rail-road axles are thus frequently rendered unsafe. In short, any change which can disturb the equilibrium of the particles, and permits any freedom of motion among them, favours the reaction of the polar or axial forces, and promotes crystallization.

Magnetism influences and promotes crystallization. When nitrate of mercury on a glass plate is placed over the poles of an electro-magnet, as in Fig. 22, crystallization takes place in the

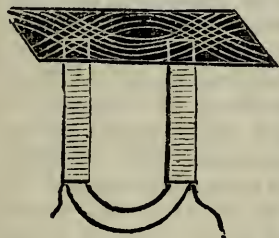


Fig. 22.

curved lines here shown. By substituting a plate of copper for the glass, it is curiously etched in the magnetic curves by the acid of the silver

salt. These experiments may be much varied by the ingenuity of the learner. The observations of Mr. R. Hunt have given us much new information on this point.

Polarity of Molecules. — The laws of crystallization show that the molecules (or ultimate particles of matter) have polarity. That is, these molecules have three imaginary axes passing through them, whose determinations, or poles, are the centre of the attractions by which a series of similar particles are attracted to each

other to form a regular solid. These molecules are either spheres (Fig. 23) or ellipsoids (Fig. 25), and the three axes (N S) are always either the fundamental axes or the diameters of these particles. In the sphere (Fig. 23) these axes are always of equal length, and at right angles to each other, and the forms which can result from the aggregation of such spherical particles can be only symmetrical solids, such as the cube and its allied forms. The cube drawn about the sphere (Fig. 23) may be supposed to be made

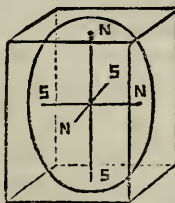


Fig. 25.

up of a great number of little spheres (Fig. 24), whose similar poles unite N and S. In the ellipsoid (Fig. 25) all the axes may vary in length, giving origin to a vast diversity of forms. All matter not subject to the vital force is endowed with such polarity inherent in its molecules.

We thus see that *atoms* or *molecules* are, as before remarked, only the centres of several forces, whose aggregate results we call matter. Under the influence of heat, the crystallogenic attraction loses its polarity and force, and the body becomes liquid or gaseous. The return to a solid state can occur again only when the attractions become polar or axial.

Crystalline Forms. — The mineral kingdom presents us with the most splendid examples of crystals; yet, in the laboratory, we can imitate the productions of Nature, and in many cases produce beautiful forms from the crystallization of various salts, which have never been observed in nature. The learner who is ignorant of the simple laws of crystallography, sees in a cabinet of crystals an unending variety and complexity of form, which at first would seem to baffle all attempts at system or simplicity. Numerous as the natural forms of crystals are, however, they may be all reduced to six classes, comprising only thirteen or fourteen forms, which are called the primary forms, because all other crystalline solids, however complex or varied, may be formed from them by certain simple laws.

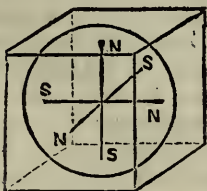


Fig. 23.



Fig. 24.

(To be continued)

LESSONS IN FRENCH.

(Continued from page 144.)

Of Names of Cities.—As we have already remarked, names of cities, although spoken of as a whole, take no article, because the mind never refers to their extent; but when used as common nouns, they follow the general rule; thus we say:

Paris, London, and Madrid are (some) beautiful cities.	<i>Paris, Londres, et Madrid sont de belles villes.</i>
Havre, New Orleans, and New Granada are (some) commercial cities.	<i>Le Havre, la Nouvelle Orléans, et la Nouvelle Grenade sont des villes commerçantes.</i>

The prepositions used before names of cities will be found in the following examples:

Where do you live? I live in Paris.	<i>Où demeurez-vous? Je demeure à Paris.</i>
Where are you going? I am going to Paris.	<i>Où allez-vous? Je vais à Paris.</i>
Where have you bought this carriage? I bought it in Paris.	<i>Où avez-vous acheté cette voiture? Je l'ai acheté à Paris.</i>
When you went to Italy, did you pass through Paris?	<i>Quand vous allâtes en Italie, passâtes vous par Paris?</i>
Where has this robber been caught? He was caught in Paris.	<i>Où ce voleur a-t-il été pris? Il a été pris dans Paris.</i>
What would France be without Paris?	<i>Que serait la France sans Paris?</i>

These prepositions are the only ones which can embarrass foreigners; the others, when used, are the same in both languages.

Names of cities may become common nouns in the following manner: London is the Paris of England; *Londres est le Paris de l'Angleterre*. Paris, in this sentence, represents two things of the same kind, one belonging to England, the other to France; it acts, therefore, as a common noun, and being rendered definite by the expression *of England*, which distinguishes it from any other, it requires to be preceded by the article.

Of Names of Rivers used without a Preposition.—Names of rivers, when not preceded by a preposition, take the article, for two reasons:

1. Because the common noun *river* being understood before them, its suppression, which is the result of an ellipse, does not change the nature of the expression.

2. Besides, these names being then

always used in reference to the whole extent of their signification, which is that of their course, they should take the article before them, as names of countries do in similar cases; thus we say: The Mississippi is a large river; *Le Mississipi est un grand fleuve*; which signifies that the whole extent, or course of the river Mississippi is very large. This rule has no exception.

Of Names of Rivers used with a Preposition.—When a name of a river is employed with a preposition, it is necessary to remark whether this name is used in reference to the extent of its meaning or not: in the first case it takes the article, in the second it does not; for instance, in this sentence, Which water do you drink? I drink the water of the Seine; it is evident the noun *Seine* does not refer to the extent of the course of that river; it only shows what kind of water you drink; it is a mere qualification of the preceding noun *water*; it is therefore indefinite, and the above sentence is expressed by, *De quelle eau buvez-vous? Je bois de l'eau de Seine*. But if I say, I drink the water of the *Seine* because that of the *Marne* is muddy, it is clear that my mind refers to the whole course of these two rivers. The meaning of this sentence is: the whole course of the *Marne* being muddy, and the whole course of the *Seine* being clear, I drink the water of the latter in preference to that of the former. The article is then necessary to show this view of the mind, and the above sentence is thus expressed: *Je bois de l'eau de la Seine parceque celle de la Marne est bourbeuse*.

Although this is the rule, and may be applied with safety in most cases, usage requires that in sentences similar to the former of the two preceding examples, the article should be used, although the extent of the course of the river is not alluded to; it would be against usage, for instance, to say, *Je bois de l'eau de Mississippi, de Garonne, de Rhône, &c.* The article *the* is here required by custom, and this sentence should be, *Je bois de l'eau du Mississippi, de la Garonne, du Rhône, &c.* The common noun *river* is then understood before these several names of rivers, and requires the use of the article on account of the ellipse which is the result of its suppression.

We say, also, River water is soft, *L'eau de rivière est douce*; Sea water is salted, *L'eau de mer est salée*, without the article, because *rivière* and *mer* are used only to qualify *water*, without defining the extent of the signification of the word *water*; but if we speak of the water which fills up the depths of the sea, as a quantity of water, then we say, The water of the sea, *L'eau de la mer*, because it signifies the whole of the water which fills up that part of the globe which is covered with water.

Of Common Nouns used sometimes with the Article and sometimes without it.—The article should not be used before common nouns, unless they are employed to express a whole species, a distinct class, or a single individual of a whole species, or a part of a whole, when that whole is understood by the mind in a definite sense. We will then establish the following rules:

Of Nouns used as Titles of Chapters, Books, Documents, &c.—When a noun is used as a title of a chapter, it is necessary to examine the nature of that noun and the sense in which it is used.

1. When the noun used as a title is employed in its general and abstract meaning, whether in the singular or plural number, it takes the article; as, *Life, la vie*; *Vengeance, la vengeance*; *Love, l'amour*; *Reflection, la réflexion*, &c. These nouns, thus preceded by the article, indicate that the chapters of which they are the title, will treat of the ideas, persons or things represented by these nouns in a general point of view, without reference to any particular instance of life, vengeance, love, &c. Used without the article, these nouns would indicate that the chapter of which they are the title will contain a particular instance of love, vengeance, life, reflection, &c.

2. Whenever a noun expressing an idea or a fact, is restricted in its meaning, as in, *Life of a wise man*, *Vengeance of a woman*; *Love of a mother*, *Reflections of a hermit*, &c., the article is generally dispensed with, although it is not a fault to use it, and the above expressions are rendered by,

<i>Vie (or la vie) d'un sage.</i>	<i>ance) d'une femme, or</i>
<i>Amour (or l'amour)</i>	<i>yet une vengeance de</i>
<i>d'une mère, or yet un</i>	<i>femme.</i>
<i>amour de mère.</i>	<i>Réflexions (or les réflex-</i>
<i>Vengeance (or la venge-</i>	<i>ions) d'un hermite.</i>

3. If the noun used as a title is applied to persons, or things which have a material representation as a book, a horse, a dog, &c., it is always, and without exception preceded by the article; as,

The dog.	Books.	<i>Le chien.</i>	<i>Les livres</i>
The dog of Alexander.		<i>Le chien d'Alexandre.</i>	
The book for little chil-		<i>Le livre des petits en-</i>	
dren.		<i>fants, &c.</i>	

4. When the noun used as a title does not represent an abstract idea, but a thing which has no material representation, as, history, documents, judgment, memoirs, proclamation, &c., it is never preceded by the article; as,

Ancient History.	<i>Histoire ancienne.</i>
Documents on the	<i>Documents sur la révo-</i>
French revolution.	<i>lution Française.</i>
Judgment of the rob-	<i>Jugement, condamna-</i>
bers.	<i>tion des voleurs.</i>
A proclamation of the	<i>Proclamation du Roi;</i>
king.	<i>&c.</i>

5. Whenever the noun used as a title of chapter is an adjective used as a noun, the article precedes it invariably; as,

The converted.	<i>Le converti.</i>
The blind man.	<i>L'aveugle.</i>
The friend.	<i>L'ami.</i>
The guilty man.	<i>Le coupable, &c.</i>

6. If the noun used as a title of a chapter is employed to designate in a particular manner a thing or a person among others of the same kind, it is then preceded by the adjective *a, un*; as,

An affair of honour.	<i>Une affaire d'honneur.</i>
A bachelor's hall.	<i>Un ménage de garçon.</i>
A marriage under Louis	<i>Un mariage sous Louis</i>
XV.	<i>XV., &c.</i>

7. If the name is used to announce that the subject of the chapter is about to be scientifically and completely treated, that name is preceded by the article and the preposition *of, de*; as,

Of the weight of the	<i>De la pesanteur de l'air</i>
atmosphere.	
Of chronic diseases.	<i>Des maladies chro-</i>
	<i>niques, &c.</i>

But if the subject, although scientifically, is not completely treated, it is preceded by the article and the preposition *on, sur*; as,

On the composition of	<i>Sur la composition de</i>
water.	<i>l'eau.</i>
On the balloons.	<i>Sur les ballons.</i>

Of Directions.—When giving the direction of a person, we may mention the name of the street without telling the

number of the house where that person lives; as, *My father lives in Milton-street*, which means somewhere within the extent of that street, and the individual who receives such direction is compelled to go from one end of the street to the other to find the house; the name *street* being then used in reference to the extent of its signification, which is the length of each of its sides, requires to be preceded by the article; and the above sentence is rendered by, *Mon père demeure dans la rue Milton*. But if the number is given, as well as the name of the street; as, *My father lives in Milton-street, No. 24*, the mind refers no longer to the extent of the street; the person spoken to sees the house at once, and the part of sentence, *in Milton-street, No. 24*, stands as a sort of adverbial expression, as if the house being pointed with the finger, the person who speaks should say, *My father lives there*. *In the* is then suppressed, and the sentence is expressed by, *Mon père demeure rue Milton, numéro vingt-quatre*. Although this is the principle, usage allows that the first sentence should be rendered by, *Mon père demeure dans la rue Milton*, or simply, *rue Milton*; but *dans la* in the second sentence would be a fault.

If, speaking of a man, I say, *He is in gaol*, the noun *gaol* is not intended to indicate any particular gaol; it does not refer to the extent of the gaol in which the man is kept; the sentence indicates only the situation of the man spoken of as being a prisoner; *gaol* is therefore indefinite, and requires no article; as a consequence, *in* is expressed by *en*, and the sentence rendered as follows: *Il est en prison*. If, going to a gentleman's house, and inquiring for him, I am told, *He is gone to the gaol*, the noun *gaol* represents the idea of a particular gaol which the person who speaks knows, and that I am supposed to know myself; that noun is then definite; it requires the use of the article, and the sentence is rendered by, *Il est allé à la prison*. I go to the gaol, inquire for the gentleman, and I am told, *He is in the gaol*; this sentence signifies that the gentleman is to be found within the limits of the gaol; this name is then used in reference to the extent of its signification, which extent is that of the gaol itself; it is definite, and the article

should be used with the preposition *in*, which is then rendered by *dans*, and the sentence is expressed as follows: *Il est dans la prison*.

According to the same principle, *to be accidentally in town*, when we live in the country, expressing only the situation of the person spoken of, as *to be in gaol*, is rendered by, *être en ville*. *To be in town*, meaning to have left the country and to live in town altogether, is rendered by, *être à la ville*. *To be in town*, meaning to be out of the house and within the limits of the town, is expressed by, *être dans la ville*. If, speaking of a man, I say, *He speaks as a sensible man and acts as a fool*, the two expressions, *as a sensible man* and *as a fool*, are adverbial, qualify the verb to speak, and are therefore indefinite; the genius of the language requiring that *as a* should be rendered by *in*, the preposition is expressed by *en*, and the sentence stands as follows: *Il parle en homme sensé et agit en fou*.

SYSTEM OF ELOCUTION.

(Continued from page 141.)

Inflections.—Inflections, in the science of elocution, are notes of speech—notes that, in regard to pitch, undergo a continual change during the time of their pronunciation.

Writers on elocution describe six different notes of speech; namely, the *rising inflection*, the *falling inflection*, the *acuto-grave circumflex inflection*, the *gravo-acute circumflex inflection*, the *acuto-gravo-acute circumflex inflection*, and the *gravo-acuto-grave circumflex inflection*.*

In the rising inflection, the movement of the voice is from grave to acute; in the falling inflection, from acute to grave; in the acuto-grave circumflex, from grave to acute, thence back to grave; in the gravo-acute circumflex, from acute to grave, thence back to acute; in the acuto-gravo-acute circumflex, from grave to acute, thence back to grave, and thence again to

* Mr. Steele calls the inflections of the voice *accents*—acute, grave, and circumflex. Dr. Rush denominates the rising inflection, the rising concrete; the falling inflection, the downward concrete; the circumflexes he calls waves.

acute; in the gravo-acuto-grave circumflex, from acute to grave, thence back to acute, and thence again to grave.

In that part of this work which consists of EXERCISES IN READING AND DECLAMATION, these notes of speech are represented by the acute, grave, and circumflex accents, thus: rising inflection (´); falling inflection (`); acuto-grave circumflex (^); gravo-acute circumflex (v); acuto-gravo-acute circumflex (~); gravo-acuto-grave circumflex (^^).

In reading and speaking, each syllable has some one of these inflections; but, for practical purposes, it is necessary to mark those only which are emphatic.

The various movements of the voice, in song and speech, may be explained in the following manner:

When the bow is drawn across an open string of the violin, or any of its species, a sound is produced of a uniform pitch, from beginning to end. This sound is a pure note of music, and, so far as pitch is concerned, is identical with a note of song. When the bow is drawn across the same string, while the centre of the string is pressed down with the finger, a sound is produced similar to that of the open string, but an octave higher. The intermediate notes of the diatonic scale may be produced by pressing down the string, at the proper places, and drawing the bow across it.

When a string of the violin is pressed down by the finger, and, at the same time, the finger is made to slide upon it towards the bridge of the instrument, during the drawing of the bow, a sound is produced which gradually increases in acuteness from beginning to end. When the finger is made to slide in the opposite direction, during the drawing of the bow, a sound is produced which gradually increases in gravity during its prolongation. When the finger is made to slide towards the bridge, and thence back again, during the drawing of the bow, a simple circumflex note is produced. When the finger is made to slide towards the bridge, thence back again, and thence again towards the bridge, during the drawing of the bow, a compound circumflex note is produced.

Other varieties of the slide might be given, but these are sufficient to answer the purpose of explanation:

"The slide is a grace of much simplicity and beauty, evidently drawn from Nature. It expresses the most tender and affectionate emotions: we hear it in those little gusts of passion which mothers use in caressing their infants; it is one of the most endearing tones in the language of nature.

"The *portamento*, or carriage of the voice, as the Italians term it, is an easy mode of sliding from one tone to another. Hence second-rate singers find it a convenient method of encountering those notes which lie at remote and awkward distances. In some voices it is so fixed by habit, that two bars cannot be sung without it. When so used, it utterly destroys every pretence to good singing, by interposing an effect of the most sickening kind; when used with discretion, it adds much to the force of expression; and, in Madame Caradori, it was a grace both tender and agreeable.

"The violinist, Paganini, the wonder of the world, played an entire cantabile* upon one string, sliding through all the intervals with a single finger—the effect which was so plaintive and desolate as to move his audience to tears. Velluti, the first singing-master of his age, used this grace with incomparable beauty; in his voice it imparted a tenderness not to be described.

The sliding notes above described are analogous to drawing notes of speech. Speech, to be natural, requires each syllable to be uttered with a certain degree of force. This force is always in proportion to the length of the syllable. A syllable is drawled when it is pronounced with inadequate force—in other words, with force less than that which constitutes the minimum degree of natural speech.

The extent of the concrete intervals of the notes of speech is various under various circumstances. A rising inflection may be carried through the whole compass of the voice. But, in the most energetic interrogation the voice seldom rises higher than an octave; though sometimes it extends to a tenth, or a twelfth. The smallest concrete interval does not, perhaps, exceed a quarter tone.

* Cantabile, a term applied to movements intended to be performed in a graceful, elegant, and melodious style.—*Busby's Dict. of Music.*

The concrete intervals of rising inflections are greater than those of their corresponding falling inflections. This may be illustrated by pronouncing the letter *a* interrogatively and affirmatively, several times, with increasing energy, making the intervals of each succeeding pair greater than those of the preceding.

Rising inflections are far more numerous than falling inflections: the former constitute the main body of oral language, while the latter are employed for the purposes of emphasis, and in the formation of cadences. Rising inflections are often emphatic; but their emphasis is weaker than that of falling inflections.

The circumflexes are used for the purposes of emphasis. The acuto-grave circumflex, when carried through a wide interval, is employed for the expression of irony and scorn.* When the circumflexes are properly introduced, they are very expressive. These movements of the voice, however, are seldom required; when improperly employed, they affect the ear of a good reader as unpleasantly as the too frequent use of the portamento does that of a good musician.

Writers on elocution have given numerous rules for the regulation of inflections; but most of these rules are better calculated to make bad readers than good ones. Those founded on the construction of sentences might, perhaps, do credit to a mechanic, but they certainly do none to an elocutionist.

The subject is of such a nature that it would be difficult, if not impossible, to give rules for the regulation of all the inflections of the voice, in reading and speaking; and, as any rule on this part of elocution must necessarily be limited in its application, I have thought proper to dispense with them altogether. This work, however, does not leave the reader without a guide: in the practical part of it numerous examples are given, which, I trust, will have a tendency to form a correct taste. When the student shall have acquired a knowledge of the principles of elocution, he will have no occasion for rules.

* "The circumflexes, *acuto-grave*," says Mr. Steele, "are characteristic of the Irish tone; and the circumflexes, *gravo-acute*, are characteristic of the Scottish tone."

The reader should bear in mind that a falling inflection gives more importance to a word than a rising inflection. Hence it should never be employed merely for the sake of variety; but for emphasis and cadences. Neither should a rising inflection be used for the sake of mere "harmony," where a falling inflection would better express the meaning of the author.

The sense should, in all cases, determine the direction of inflections. Hence the absurdity of the term "harmonic inflection," as employed by Walker and his disciples—an inflection which, for the sake of harmony, takes a direction contrary to that required by the sense! If a sentence is pronounced so as to bring out the sense in the most forcible manner, all the inflections must necessarily be harmonic, or, more correctly speaking, melodic. Every modification of the voice, which is not compatible with the sentiment, weakens the force of the elocution by drawing off the attention of the hearer from the sense to the sound.

Melody.—Melody is a series of simple sounds, emanating from the voice, or an instrument, so varied in pitch as to produce a pleasing effect upon the ear. The series of graphic notes by which these sounds are represented is also called melody.

Melody is distinguished from harmony by not necessarily including a combination of parts. The term harmony, as employed in the science of music, signifies a union of melodies, a succession of combined sounds, moving at consonant intervals, according to the laws of modulation.*

Notation is the graphic representation of a melody—in other words, the expression of a melody by written characters.

Intonation is the act of sounding the notes of a melody, either with the voice or an instrument. When each note is produced in its proper degree of pitch, the intonation is true; when the intervals are not observed with exactness, the intonation is false. Correct intonation, in speech, is highly important; in song, and

* The term *harmonious* is correctly employed when applied to two or more sounds whose union is consonant, or agreeable; it is incorrectly employed when applied to the notes of a single melody, as is done by some authors, who confound it with the word *melodious*.

instrumental music, it is indispensable; for, if the intonation is false, melody loses its charms, and harmony becomes discord.

The melody of speech is founded on sense; that of song, generally, on sound. Words containing opposite sentiments may be sung to the same air, with effects equally good, if the force and time be properly varied. Thus, if the two songs, "March to the Battle Field," and "Oft in the Stilly Night," be sung to the same air—the former with great force, and in quick time—the latter with diminished force, and in slow time, there will be as much difference of expression between them as there is between that of joy and sorrow.* But speech is not so accommodating. Here every sentence must not only have its appropriate tune, but the tune must be properly pitched.

The melody of song is graduated on a scale whose degrees are as definite as those of the scale of Gunter. But the melody of speech is not formed with such mathematical exactness—it has no scale of determinate degrees. Hence it is difficult to represent it graphically—to give to each note

"A local habitation and a name."

But even if an exact notation of the melody of speech should be given, it is doubtful whether it would be of much practical importance to the generality of mankind, as none but a Paganini would be able to read it. Such a notation, however, is a desideratum—it would be highly interesting to the philosopher; and I would advise all elocutionists who have a good ear for music, and can perform on stringed instruments of the violin species, to direct their attention to the subject.†

For practical purposes, however, it is not essential to present every syllable in speech under its proper note, as is done in song: it is only necessary to give a notation of the relative pitch of the emphatic syllables. Such a notation may be read

by those who have no knowledge of music whatever, and, consequently, does not require the aid of a Paganini. Besides, if the relative pitch of the heavy, or emphatic syllables, and their inflections, are given, the light, or unemphatic syllables will naturally take their proper degrees of elevation.

Time.—Time is the measure of sounds in regard to their duration.

Time, in song, and instrumental music, is divided into equal measures by rhythmical pulsation—in other words, by a periodical return of similar accents.* In graphic music, these measures are rendered conspicuous to the eye by vertical bars, as in the following line of poetry:

| Hail to the | chief who in | triumph ad- | vances, |

In speech there is also a return of similar accents; but they do not always occur at regular intervals of time. Hence the rhythm of speech, like its melody, is more or less irregular.

The time of a note, or syllable, is called quantity. The time of a rest is also called quantity, because rests, as well as notes, are a constituent of rhythm. Hence the characters used for the expression of quantity are either of sound or silence. The former are called notes; the latter, rests.

There are two general modes of time—common and triple. In common time each measure is divisible by 2; in triple time each measure is divisible by 3.

There are several varieties of each of these modes of time. When a piece is in common time, and each measure contains two quavers, or their equivalent, the figures $\frac{2}{8}$ are prefixed to the words, or the music; when each measure contains two crotchets, the figures $\frac{2}{4}$ are prefixed; and when each measure contains four crotchets, a capital C, or the figures $\frac{4}{4}$ are prefixed. When a piece is in triple time, and each measure contains three quavers, the figures $\frac{3}{8}$ are prefixed to the words, or the music; when each measure contains three crotchets, the figures $\frac{3}{4}$ are prefixed; and when each measure contains six quavers, the figures $\frac{6}{8}$ are prefixed to the words, or the music. The upper figure, in each of these cases,

* The reader must not infer that we entertain the opinion that in song melody cannot be adapted to sentiment. We believe that if the composers of music were *elocutionists*, they would always construct their melodies with reference to the sentiments to be expressed.

† Any essays on this subject by one who cannot perform on a musical instrument, must prove entirely abortive.

* It is rhythmical pulsation which enables a band of musicians to perform in concert. It is this also which enables a company of soldiers to march synchronously, and which governs the movements of the feet in dancing.

shows how many notes of a certain description there are in each measure; and the lower figure, how many of these notes are equal in value to a semibreve.

Movement.—Movement is the velocity with which a sentence is read or sung, or a strain of instrumental music is played.

The rate of movement should be such as the sentiment demands. Solemn discourse requires a slow movement; simple narrative, a medium rate of utterance; animated description, as well as all language expressive of any sudden passion, as joy, anger, &c., a movement more or less rapid, according to the intensity of emotion. In the science of music, various terms have been employed to denote the rate of movement, the principal of which are the following:

ADAGIO very slow, the slowest time.

Largo slow time.

Larghetto.... slow, but not so slow as largo.

ANDANTE .. medium time.

Andantino ... a little quicker than andante.

Allegretto.... rather quick, but not so quick as allegro.

ALLEGRO .. quick time.

Presto very quick.

Prestissimo .. as quick as possible.

Adagio, andante, and allegro, are the three chief divisions of time; the other terms mark the intermediate degrees.

In addition to the foregoing terms, which mark the movement, there are others, which indicate the style of performance. Some of these are as follows:

Affettuoso .. affectionate—a soft and delicate style of performance.

Brillante .. shining, sparkling—a gay, showy style.

Furioso .. fierce, mad—a vehement style.

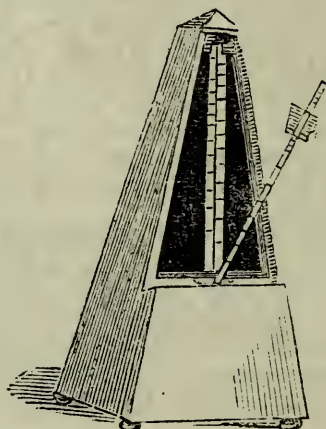
Spiritoso .. spirited—a spirited style.

Sometimes these terms are used in connection with those which express the rate of movement, thus:

Allegro con spirito, quick with spirit—in a quick and spirited manner.

The rate of movement is not definitely marked by the terms Adagio, Largo, Larghetto, &c.; it may, however, be designated with precision by means of the metronome of Maelzel. This instrument has a graduated pendulum, to which is attached a sliding weight. The higher this weight is moved upon the pendulum, the slower are its vibrations; and the contrary. When the weight corresponds to

the number 50, the vibrations of the pendulum are the slowest; when it corresponds to 160 they are the quickest. All the numbers on the instrument have reference to a minute of time. Thus, when the weight is placed at 50, fifty beats, or ticks, occur in a minute; when at 60, sixty beats in a minute; when at 100, one hundred beats in a minute, &c. The engraving below represents the instrument in action.



In reading, as a general rule, the time should be marked on the metronome by whole measures—in other words, each measure should correspond to one tick of the instrument.

In music, it is most convenient to mark the time on the metronome in *adagios*, by quavers; in *andantes*, by crotchets; in *allegros*, by minims; and in *presto*s, by whole measures.

(To be continued.)

MATHEMATICAL PROBLEMS.

1.

In a plane triangle there is given the sum of the sides, the difference of the angles at the base, and the length of a line drawn parallel to the base, dividing the triangle in a given ratio, to determine the triangle.

2.

Two merchants barter. A. has cloth worth 14s. a yard, but in barter will have 16s. B. has 300 jackets, worth 45s. each, but in barter will have 50s. Now how much must B. have in ready money that he may gain 10 per cent. ?

PRACTICAL LESSONS IN DRAWING.

(Continued from page 137.)

2. SECOND LESSON.

You have had some simple exercises in straight lines, and as these have been drawn correctly, and you appear to have overcome all the *little* difficulties that beset your path at the onset, you must now commence some more difficult subjects.

Draw a perpendicular line, and from the lower part of it draw a horizontal line from right to left, as *b* in Fig. 5.

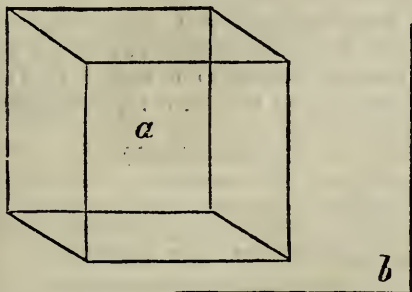


Fig. 5.

Draw four horizontal lines, and then join their extremities by four perpendicular lines as in *a* Fig. 5. This will represent a block of wood (called a *cube* in geometry), having six faces, and eight corners or angles, like a die.

When we arrive at our lessons upon angles and geometrical figures, you will be better able to understand the true meaning of many of the terms used in drawing; but until then, it will be better for you to acquire freedom in the use of your pencil and precision in drawing, and this can only be accomplished by practice and attention to the directions we have given already.

Here is another geometrical figure which you are requested to copy. To do

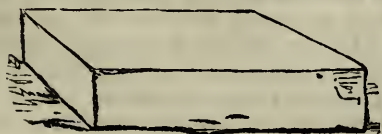


Fig. 6.

so correctly, begin by making two dots and then forming the upper line; then

calculate that the distance of the second line is twice the depth of the fore part of the stone (which is represented in Fig. 6), and draw a *very faint short* stroke to fix the distance. You must now fix the place to commence the second line, and you therefore place a dot at about the same depth as the fore part of the stone towards the right, and another dot at about one and a half of the depth from the right of the end of the upper line; then draw a line between the two dots. Join the ends of these two lines by oblique lines, as represented in the figure above, and proceeding in the same manner to place dots upon the paper for the other parts, draw the short perpendicular lines and the oblique and horizontal lines. The figure is now complete in outline, and you must therefore finish it by the addition of a few strokes and dots, as shown in the figure.

To form the outline of the figure, use F pencil, and an H B to fill in the other strokes.

Here is another figure that you must

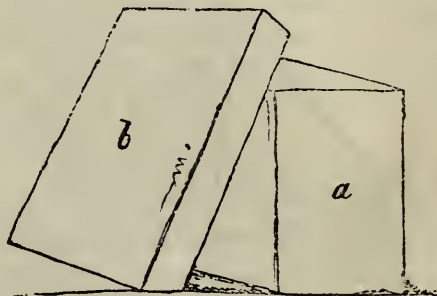


Fig. 7.

practice frequently, because it will give you a fair knowledge of the combination of form and proportion, and will school your eyes to the perspective of solids. In this, as in all cases, proceed by making dots before you commence drawing your lines; and we merely repeat this again, because we wish our pupils to understand most distinctly that *no line should be drawn until the length of it has been marked upon the paper by dots*. Having said this much, and referred the pupil to our directions at page 136, we shall not consider it necessary to mention the subject again. When you have drawn the upper horizontal line of *a* in Fig. 7, draw a perpendicular line from each end of it, and let each of these

lines be one and a half the length of the horizontal line; then unite the two lower ends of the perpendicular lines. Now draw a faint horizontal line along the base of *a*, and at about half the height of the oblong *a* place a dot on the faint horizontal line, and another dot at rather more than a third of the length of the dot just placed upon the line from the left lower angle of the oblong. You must then place a dot at about half the length of the above distance above the horizontal line and the same distance from the second dot as the width of the base of *a*. From these several dots, draw oblique lines, as in *b*, Fig. 7, and join them by other lines, as shown in the figure. You must now draw other short lines from the oblique ones to the face of the oblong, and finish the figure by a few short strokes at the base, as shown in the above figure.

It is required to represent the two sides of a pyramid. Draw two faint horizontal

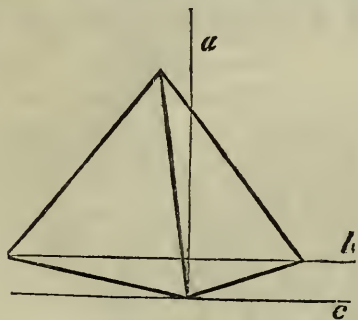


Fig. 8.

lines *b c*, and another one *a*, perpendicular to them, then draw a line from *c* to *b*, commencing at the place where *a* cuts *c*; then draw another line from *c* to *b* one third longer than the line on the right of *a*, commencing at the point of junction between *a* and *c*. Place a dot on the left of the perpendicular line *a* at nearly the same distance from it, as the space between the lines *b* and *c* and twice the length of the oblique line on the right of its base, between the lines *b c*. From this point or dot, draw lines to meet those drawn before, and the figure will be complete.

Draw a horizontal line, *a b*, and then draw a perpendicular line, *c d*, across it, as in Fig. 9.

You will have formed four right angles *a e c*, *c e b*, *b e d*, *d e a*; but we are not

going to study angles now; that is not our object. We wish you to notice our remarks and practice the figure; then when you

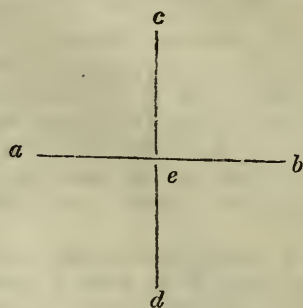


Fig. 9.

can draw this well, you should draw the lines in different directions so that *c* may be brought nearer to *b*, and *d* to *a*; by this means you will form various kinds of angles.

(To be continued.)

THE GOLDEN PEACOCK.

A STORY OF KING ARTHUR.

“———what resounds
In fable or romance of Uther's son.”
MILTON.

THE solemn ceremonials was finished, and the two faithful and valorous defenders of Britain against the Saxons—the brothers who had successively headed the British tribes as *Pendragon*, or elected emperor—Ambrosius and Uther, lay side by side in death, under that newly-erected altar of stones on the great plain of Ambry, since known as Sarum or Salisbury. November's troubled moonlight fell briefly and fitfully over the valley of Avon and the camp of the British host, assembled to bring, with all honour, the remains of their king Uther to Stonehenge for burial.

The vast circles and avenues of stone now reared themselves in ghostly darkness and stillness around the departed chiefs. A fall of snow, the first of the autumn of the year 500, had partially robed in white those great and regular masses of Druidical and sepulchral stones, and had fitly shrouded the altars that, before the introduction of Christianity, had been stained by the cruel human sacrifices of the mingled worship of the serpent and the sun. Snow-shrouded also were the

sepulchral monuments reared over the place where Hengist and his Saxons treacherously slew three hundred warriors of the best blood of Britain during a friendly conference.

"Awful memories are here," whispered Igerna, the widowed queen of Britain, to the youth on whose arm she leaned, as they stood beside the grave and within the altar-tomb of Ambrosius and Uther. The single large flat stone that formed the roof rose high above their heads; the three upright stones that supported it formed three solid walls, and there was the space of a small apartment within the enclosure. On the ground, in the centre, lay the two stones that covered the remains of the brother chiefs. On one of these now rested Igerna, muffled in black from head to foot, trembling with awe, and fear, and sorrow.

"What do we not owe to Christianity," said Igerna, "if only for its abolition of human sacrifices? O, the horrors of idolatry! O, that my son would become the champion of the Cross in Britain."

"Mother, I will,—I will defend all that is good, and hate and oppose all that is evil. I will build up the churches, and keep down the priests;"—the last clause he spoke to himself.

"For thy father's sake and his noble brother's, act thy part nobly as prince of the Silures, as heir to Britain. This solemn place should teach thee religion and patriotism; for all around us lie martyrs to our country and to the faith of Christ. Dear son, I fear to lose thee, as I have lost thy father; but I am a weak woman, and can only sit at home and weep, and pray, and suffer. Well, your duty lies elsewhere. It must be so. My comfort is, you *know* your duty. Britain will not want a leader for her tribes against this bold, this terrible foe,—this Cerdic, that is day by day encroaching on our territories."

Her inquiring tone was answered by the youth in emphatic word and gesture. He struck the sword, that he carried bare in his right hand, on the round shield that rested on his left arm, and the ringing sound carried assurance of heroic determination to the heart of the mother. "My father's sword and shield shall never be disgraced by me! But call me hence-

forth, mother, king of Cornwall only; for that is my birthright, and I will hold it whoever gainsays; but this symbol," striking the boss on the centre of the shield, which depicted a dragon's head, "is not for me until I have fairly won it for myself. I will be Pendragon in my own right,—I will drive these Saxons forth of the land, and then the British chiefs, if they will, may elect me for their head, as they did my father."

"Ah, my son, to drive the Saxons out were a task beyond human power. It is fifty years since they first landed in Kent, and the Saxon kingdom of Kent stands firm. The sons of Hengist were surely slain by thy father at Verulam, but hosts of formidable warriors remain behind, and still they come from over sea, like a plague of locusts to eat up the land. Their numbers no man can count; and Ella has set up his kingdom of the South Saxons. And now this dread Cerdic has taken the Isle of Wight and the parts that adjoin Ella's kingdom westward; so he is on our very borders,—and O! for dear life's sake, and for our blessed Redeemer's sake, be strong against him."

"Fear not, dear mother, fear not; I see the danger is imminent, but I will guard you well, and my dear home and kingdom."

"Your father's spirit will be with you, and the God of battles will protect you," said Igerna. "One word more in this solemn spot. You know your father was a descendant of a Roman Emperor, Constantine, and I am a Pict. Preserve your dignity, therefore, with the Romans, and as to the Picts,—when I am laid by your father's side beneath this stone, remember to protect and assist my kindred of the northern tribes against their cruel invaders, the Scots, who are pressing on in the north from the island of Scotia, to seize the kingdom of the Picts, as Cerdic the Saxon presses on to seize your kingdom, here in the west and south."

"I will remember," said Arthur. "And now, mother, Merlin tells me that Lotho, king of Strathclyde, husband of my father's sister, Anna, desires to succeed to my birthright, saying that the brother of my father, being of maturer age, should be preferred before me, that being most

consistent with established usage among the people of the west and north."

"It is so, Arthur; I cannot gainsay it. Fifteen years have not gone by since thou lay a sweet infant in these happy arms, that clasped thee with continual love, my first and only child. Thou art too young for thy inheritance, says Lotho, and he is counted wise. His word has weight. Lotho's son, Mordred,* is thy friend; he is to thee a brother, brought up with thee, taught with thee, of thine own age, and, as I think, thy equal in ambition, if not in merit. What says Mordred to his father's claim?"

"Mother, Mordred would defend me and mine. I love him next to thee and my father's memory. He shall dwell with me, and fight with me, and reign with me. Let us talk no more here, dear mother; you are cold, and ill. Let us return to the camp, I implore you."

"I cannot tear myself from this dear tomb,—O that I could stay here for evermore. My life, my happiness, is here."

She sank down on her knees, and pressed her forehead and lips to the icy stone, calling aloud on the name of Uther. A guard of British soldiers, on a summons from Arthur, issued from a shadowy cromlech near, bearing a hand-litter, surrounded by thick black curtains. In this the mourning widow was placed with careful solicitude by her affectionate son, and she was borne away to the British camp.

Arthur shortly returned with his mother to his birthplace and home, the Castle of Tintagel, in Cornwall. There rallied around him the chiefs of his tribe, the Silures, and he selected the men who appeared to him brave and wise, and formed them into a company, for which a "Round Table" was always kept covered in his hall and council chamber. The symbol of this martial company was a peacock, and at every feast they held, a peacock was roasted and served up as the principal dish. A golden peacock was also set on the centre of the table, and, after the repast, every warrior stood up and renewed the "Oath of the Peacock." In

this oath they vowed to war to the death against paganism and the Saxon invaders of their land, and to root them out, to pay tribute for Britain to no nation, to raise up the Christian church, to stand manfully by each other, with true and earnest minds, and to live and die for the good of their land, the rights of King Arthur, and the glory of God. The fame of this order spread abroad, and soon admission was not confined to the Silures, for the best men of every tribe in Britain were glad to enter the order, until the Round Tables of the warriors were so many, that the broad castle of Tintagel could not hold them. And the chiefest man of them all, after Arthur, was Mordred, the son of his uncle Lotho. Mordred had gained much influence over Arthur, for they had been brought up together, trained together in arms, and Mordred's gentle and respectful attentions were unremitting. Never did Arthur meet opposition from Mordred, never did Mordred give him counsel that he liked not. Consummate tact enabled Mordred to keep clear of the rocks and whirlpools in that character which was to his as a fair, wide, and open sea, to the deep, deep, and chilly well, dug down in the darkness of the earth. There were times when Arthur saw, but would not believe he saw, the cold selfishness of Mordred's disposition. Always himself open, generous, and unsuspecting, he delighted to heap benefits on his relative, and to display an uncommon friendship for him. But the basest ingratitude lurked in the soul of Mordred. His heart was cold to Arthur as the mountain snows; he envied his good qualities, and his successes, and was secretly plotting to overthrow him. The young king did not begin his martial career with idle shows merely; and the first time he led his army against the Saxons a victory was gained, so brilliant, that Cerdic, the Saxon chief, became aware that he had a new and difficult enemy to contend against. Indeed the genius of Arthur in military affairs was apparent at once to friend and foe. Energetic, resolute, inventive, he astonished gray-headed soldiers, who found an inexperienced youth, by mere intuition, plan out operations of attack and defence, on a large or a small scale, with a facility and certainty of success truly surprising.

* Mordred, or Medrod, for the name is spelled in several ways, is commonly stated to have been the *nephew* of King Arthur, but I here follow the authority of the old historian Speed.—M. B.

He saw in a moment the points of advantage and the positions of danger, and when actually out in the war, his rapid vision into all the details of the affair, his self-reliance, his native power of command, and his utter fearlessness, set him above all compeers. Mordred was always with him, in the tent and the field, quiet, reserved, humble, but fretting secretly. Often to himself he would murmur, "Why do I thus waste my time in playing the foil to him? I am a fool. Lotho, my father, should have torn the kingdom out of his hand while he was a weak, unknown boy. Now Lotho sleeps the eternal sleep, and I am left to bite my nails, and applaud my cousin."

A second victory over Cerdic the Saxon drew closer around Arthur all the strength and power of Dumnonia (Devon), Cornwall, Cambria (Wales), Cumbria (Cumberland), and Strathclyde, and the whole island rejoiced that a new champion had risen to save them from the Saxons. But the envy of Mordred increased.

One day a wearied horseman stood at the castle gate of Tintagel,—that invincible stronghold, which had become the headquarters of the confederated Britons. He had ridden hard night and day to bring to King Arthur a message of life and death from Brude, the Pictish king of the northern tribes. Brude, the Christian king of the Picts, greeted King Arthur, and implored him, by the memory of his mother (for Igerna slept by the side of Uther), to help the people of her race and kindred, who were threatened by a double invasion of the Scots and Saxons. The colony of Scots from the island of Ierne (Ireland), which Caerbry Riada, Prince of Dalriada, in Ulster, had founded two hundred and fifty years before, had dwelt undisturbed on the western borders of the Pictish kingdom; but now Lorn, Fergus, and Angus, the sons of Erck, Prince of Dalriada, were landed with a great army of Scots on the Pictish territories, and Brude implored the help of Arthur and the strong men of the west.

Arthur remembered his mother's commands, and was soon away to the north, like a fiery comet with his blazing train. There was a battle between the Picts and the Scots, and Arthur achieved another victory. And still Mordred was ever at

his right hand, gentle, courteous, and silver-tongued, but fretting with envy and mortified ambition. "For who spoke of Mordred? Who blazoned forth *his* name? What bard sang of *his* exploits? What kingdom boasted of *his* rule?" So he bitterly questioned himself, and repined at fate. Another source of pain was now to be opened for him.

The king of the Picts' fair daughter, Guinever, filled with gratitude for the services rendered to her father, and to the Pictish kingdom, wrought with her ladies a banner displaying a golden peacock, which she herself presented, with graceful homage to him, as he sat in his tent, with Mordred by his side. King Arthur was enchanted by her beauty, and still more by the wise and earnest words that she spake, and, turning to her father aside, he said, "This were a wife worthy to be queen of Britain;" to which Brude gravely and firmly rejoined, "She is worthy of that honour, but I do not covet it for her."

"What sayst thou, Mordred?" said Arthur, turning pleasantly toward him. Mordred was confused. "Say—my lord king," he repeated, and his colour rose; but Arthur clapped him on the shoulder with a kindly laugh, and told him, if he were smitten with love of the lady, to make speed to woo, for else he prophesied Guinever would be queen of Britain. And Mordred did make speed, for he sought the lady, and with his utmost blandishments pressed her to accept his hand; but he was refused, and presently after Arthur was accepted. Then, Mordred, how bitter was thy hatred to both! But he concealed his venomous nature, and Guinever tried to esteem him because he was dear to Arthur.

One more cause of bitterness yet remained. Arthur returned with his bride to Cornwall, and was elected Pendragon, supreme king of the British princes.

And now began Mordred to bring his envy and hatred into visible action. He first secretly leagued with Cerdic, the prime enemy of Arthur; but this was discovered through the watchfulness of Guinever, who suspected deception in him. A Saxon, disguised as a British armoured, was found to have been introduced by the traitor into the castle of Tintagel—a discovery that led to the hasty execution of



the Saxon spy, and the banishment of Mordred.

Some months passed, and Arthur had achieved his sixth victory. The heralds were ranged by the gateway of Tintagel, the knights of the Round Table were assembled in the court. Alike were they in magnificence, and proud of equality in valour and honourable fame. And there was a goodly gathering of British soldiers around the outskirts of the courtyard, gazing with curiosity, admiration, and pride.

The heralds' trumpets blew high notes of welcoming as Arthur rode into the gateway. But who is this that presents himself, bending low in homage, and, as it seems, in deep humility, before the triumphant hero? It is Mordred, bare-

headed, alone, casting himself on the generosity and magnanimity of the man he has so deeply injured; and well he knows that in so doing he takes a sure path to the noble heart of the hero.

Arthur recognised him in a moment, and his feelings, ever quick and ardent, brimmed up at first with indignation mixed with wounded affection and pity for his fallen state.

"What seek you from me?" he said, reining up his horse.

"A private conference, for the sake of our past friendship and our family honour."

"No private conference with a traitor," said Arthur, loudly; "knights, arrest him."

"Hold!" exclaimed Mordred, also loudly, "I rest my fate on the mercy of King Arthur, and the goodness of Queen Guinever. Suffer me to live, and I will serve you and Britain faithfully henceforward. I solemnly swear it, by the golden peacock."

"Forward, then, to the Queen," said Arthur.

(To be continued.)

THE MONTHS.—MARCH.

(Continued from page 148.)

THE SIXTEENTH DAY.—In 1849, Cardinal Mezzofanti, who was considered as a most extraordinary linguist, died at the age of 79.

THE SEVENTEENTH DAY is dedicated to *St. Patrick*, the tutelary saint of the Irish, who wear a bunch of trefoil, or shamrock, upon this day. Biographers do not agree with respect to the date and place of birth of Ireland's saint, Usher and Tillemont stating that he was born in the year 372, while Moore, in his "History of Ireland,"* states that he was born in the year 387. The same discrepancy occurs with regard to the date of his death, Usher fixing it on the 17th of March, 493, Tillemont on the same day in 455, Nennius in 464, and Moore in 465. Most biographers maintain that *St. Patrick* was born in a village called Bonaven Taberniæ, supposed to be the town of Kilpatrick, at the mouth of the Clyde, between Dumbarton and Glasgow; but Mr. Moore states that the saint was born in the neighbourhood of Boulogne, in the ancient Armoric Britain, and that the Irish monarch, Nial of the Nine Hostages, having ravaged some of the maritime districts of Gaul in the year 403, *St. Patrick* was taken prisoner and carried to Ireland, where he was sold to a person residing in Antrim, who employed him to tend sheep. Having continued in this place for six years, he made his escape in a vessel bound for Gaul, and afterwards entered a monastery at Tours. It is said that he constantly dreamed that he was invited to return to Ireland in the name of its people, and accordingly he set sail for that purpose, and landed at Dublin about the year 422. His adventures upon landing; his conversion of Dicho, a pagan chieftain; his performance of divine service in a barn; his celebration of Easter, by lighting the paschal fire on Easter-eve before the halls of Tara; his conversion of multitudes of King Logaire's followers, and the destruction of the great Druidical god, called *Crom a Cruach*, or the Head of the Sun, in the Plain of Slaughter, so called from the human sacrifices which

were offered to the idol; are all points of interest in the life of this saint that we might dwell upon, did not our limited space forbid it. *St. Patrick* erected several rude Christian churches, and occupied the see of Armagh, which was founded to organise his new system.

The origin of the Irish wearing the shamrock on this day is said to be from *St. Patrick* having used some of this plant as an illustration of the Trinity, when he was endeavouring to convert the Irish, after his second landing in 422.

On this day, in 1640, died Philip Massinger, the celebrated dramatic writer, author of "The Bondman," "The Duke of Milan," "A New Way to Pay Old Debts," &c., aged fifty-six years. In 1715 died Gilbert Burnet, Bishop of Salisbury, author of the "History of the Reformation," "Bishop Burnet's History of his own Time," &c., aged 72 years.

THE EIGHTEENTH DAY.—In 1745, died Sir Robert Walpole, Earl of Orford, in the 69th year of his age; in 1768, died Lawrence Sterne, aged fifty-four years, the celebrated author of the "Sentimental Journey," "Tristram Shandy," &c.; and in 1812, died John Horne Tooke, in the 77th year of his age, the celebrated author of the "Divisions of Purley," and many other miscellaneous works.

THE NINETEENTH DAY.—In 1532, died Lord John Bouchier Berners, known as the translator of "Froissart's Chronicles," besides many Spanish, Italian, and French novels.

THE TWENTIETH DAY, in this year, is called Palm Sunday, or the Sunday before Easter; so named, because on that day it was customary to carry boughs of palm-trees in procession, in commemoration of our Saviour's riding into Jerusalem, when the multitude spread their garments, &c.; "others cut down branches from the trees and strewed them in the way."* The ceremony of carrying palms on Palm-Sunday was retained in England until the reign of Edward VI.; and even now we see many people bearing branches of palm on that day, but they have to go some distance to procure them. This day is strictly kept by the Latins at Jerusalem, and the Russians of the Greek church.

* Vol I., pp. 203—226.

* St. Matthew xxi. 8.

The eve of the day is celebrated with peculiar ceremonials at Rome.

In 1727, died Sir Isaac Newton, in the eighty-fifth year of his age, one of the most illustrious philosophers and mathematicians yet known. Pope's epitaph upon this extraordinary man was as follows:—

"Nature, and Nature's laws, lay hid in night,
God said, "Let NEWTON be, and there was light."

THE TWENTY-FIRST DAY.—In 1556, Archbishop Thomas Cranmer was burnt by order of Queen Mary, after having recanted his faith in the vain hope of saving his life.

THE TWENTY-SECOND DAY.—In 1832, Johann Wolfgang Von Goethe died, in the eighty-third year of his age. As a poet he is well known and justly appreciated, for who that has read his "Faust," or "West-Eastern Divan," can ever forget the masterly hand that wrote them? He remarked that "it is with science as with one that rises early; in twilight he beholds the morning red, then impatiently looks for the sun, and when it appears he is blinded."

THE TWENTY-THIRD DAY.—In 1638, Frederick Ruysch, a celebrated anatomist, was burnt at the Hague; and in 1819, Augustus Friedrich Ferdinand Von Kotzebue, the dramatic author, was assassinated by a political enthusiast named Sand.

THE TWENTY-FOURTH DAY.—In 1603, Queen Elizabeth died, in the seventieth year of her age, and the forty-fifth year of her reign.

THE TWENTY-FIFTH DAY in the present year is GOOD FRIDAY, being the day that is held in commemoration of our Saviour's crucifixion. The oldest title given to this day is Holy Friday, or the Friday in Holy week; the term Good being used to express the many blessings that have accrued therefrom. Anciently there was a Popish ceremony practised in England of creeping to the cross; and it was customary for the kings of England to hallow rings upon this day, as a charm against epilepsy and cramps; consequently we find that these rings were termed cramp-rings. The well-known "hot cross buns" which are so vigorously called about the streets early in the morning by

itinerant venders in the following doggerel lines:

"One a penny poker,
Two a penny tongs,
Three a penny shovel,
Hot cross buns,
Hot cross buns, hot cross buns,"

are supposed to have originated in the desire to commemorate the Crucifixion by marking the only food anciently sanctioned with the sign of the cross, the custom being derived from the *eulogia*, or consecrated loaves of the Greek Church.

This day is also known as the *Annunciation Day of the Virgin Mary*, being held in remembrance of the angel's message (Luke i. 26—36), and is called *Lady-day*, being, moreover, commonly recognised as *Quarter-day* in England, or the day when rents become due, constables, &c., deliver their accounts, and overseers are appointed.

In 1688, London Charity Schools were first instituted.

THE TWENTY-SIXTH DAY.—In 1726, died Sir John Vanbrugh, a celebrated architect and dramatic writer; but as his writings have an immoral tendency, they have long since been banished from most libraries. Vanbrugh designed and built Castle Howard, Blenheim, and several other noble structures. In 1827 died Ludwig Von Beethoven, the celebrated musical composer.

THE TWENTY-SEVENTH DAY in the present year is EASTER SUNDAY, the day of our Saviour's resurrection from the tomb. The observance of Easter is as ancient as the time of the Apostles; but as it was kept upon different days by the Eastern and Western churches, the Council of Nice (A. D. 325), directed that it should be held on the Sunday which falls next after the first full moon following the 21st of March, or vernal equinox.

The word Easter is derived from the Anglo-Saxon *yst*, a storm, because tempestuous weather prevails at this season.

Many curious customs observed at Easter are still retained by us; among others, that of presenting coloured eggs to our friends on Easter Monday.

In 1699, died Edward Stillingfleet, bishop of Worcester, author of "Origines Sacrae; or, Rational Account of the Christian Faith as to the Truth and Divine

Authority of the Scriptures," and other works.

THE TWENTY-EIGHTH DAY.—In 1801, died Sir Ralph Abercromby, seven days after his victory at Alexandria.

THE TWENTY-NINTH DAY.—In 1772, died Emanuel Swedenborg, in the 85th year of his age, author of "Heaven and Hell," and many theological works.

THE THIRTIETH DAY. In 1783, died Dr. William Hunter, aged 65 years. He was the brother of the celebrated John Hunter, and author of some important medical works.

THE THIRTY-FIRST DAY.—In 1732, Joseph Haydn, the composer of "The Creation," was born at Rohran, about fifteen leagues from Vienna.

Heed not the chill winds that are sweeping along yon lanes and fields, making the trees bend and the dust fly in clouds, but put on your coat and let us take a ramble, and you will soon find

"How many a thing that pretty is, delays
The wanderer's steps beneath the sun's soft rays."

Look at the daffodil, with its gay flowers, shaking out its strong perfume in the air; how the bright yellow petals contrast with its green leaves, as it nods to the breeze! Our old gardener calls it a daffy-down-dilly; some persons call it the chalice flower, and you will often find it mentioned as the Lent-lily. There are many kinds of this plant; among them you will find the false narcissus, or true daffodil (*Narcissus pseudo narcissus*), which, although cultivated in our gardens, is generally found in damp situations, such as woods and marshy land. In the language of flowers, it is used to express delusive hope. Do you see that flower on yon mossy bank? It is the poet's narcissus (*N. poeticus*), used to express egotism. Its perfume is agreeable, and when it flowers, you will observe its pure white petals expanded round the golden crown in the centre. But here we are opposite to a bed of flowers that are almost so confused, we can scarcely distinguish them. Yet there is the crown imperial (*Fritillaria meleagris*), with its large drooping bells, symbolical of majesty; and Chalcedonian iris (*Iris Susiana*), with its striped flowers. Beyond the crown imperial you can see the Florentine iris

(*I. Florentina*), the symbol of eloquence; and, also, the snakes'-head iris (*I. tuberosa*), with its dark flowers, forming a beautiful contrast to the bright and golden celandine (*Ranunculus ficaria*), with its spotted heart-shaped leaves. When it is going to rain, the celandine closes its blossoms, and does not very speedily unfold them again. There is, also, the Van Thol tulip (*Tulipa suavolens*), rearing its red and yellow streaked cup above the bright green leaves of many a garden pet. It does not look more beautiful in the fields of Byzantium, the plains of Sharon, or the tulip-beds of the Netherlands, where they are seen

"Of different shapes and dyes,
Bending beneath the invisible west wind's sighs."

Do you not see the

"Mezereon, too,
Though leafless, well-attired, and thick beset
With blushing leaves investing every spray,"

courted symbol of a desire to please? Then there is the sponge laurel (*Daphne laureole*), with its pale yellowish flowers, hanging in drooping clusters from beneath its dark glossy leaves. And, ah! there is the pretty scorpion senna (*Coronilla emerus*), which will blossom next month; the nine-leaved coronilla (*C. valentina*); the seven-leaved coronilla (*C. glauca*), and a cluster of gentle hyacinths (*Hyacinthus orientalis*),

"that weep
All night, and never lift an eye all day"—

symbolical of game and play. As we gaze around the scene, we notice the spring sowbread (*Cyclamen vernalis*); the dogs'-tooth violet (*Erythronium dens canis*); the Eastern henbane (*Hyoscyamus physaloides*); and the common Bethlehem star (*Ornithogalum umbellatum*.)

When the lovely and delicate flowers of the almond-tree (*Amygdalus communis*), make their appearance, the agriculturist hails them with delight, although it is an emblem of indiscretion. For what says Dryden:

"Mark well the flowering almond in the wood;
If odorous blooms the bearing branches load,
The glebe will answer to the sylvan reign,
Great heats will follow, and large crops of grain."

But if a wood of leaves o'ershade the tree,
Such, and so barren, will the harvest be;
In vain the hand shall vex the threshing floor,
For empty straw and chaff shall be thy store."

On your old wall the common whitlow grass (*Draba verna*), is conspicuous above the low green moss, and its small white blossoms breaks the monotonous verdant line. Close at hand you may see the shepherd's purse (*Capsella bursa pastoris*), which most of us knew in our young days as pick-my-heart-out, or pick-purse. It bears many names; for example, St. James's - wort, case - weed, poor man's parmacetic, &c. If you wander along the lanes, and search the shady hedge-banks you will find a small green flower, with a musk-like scent, which is very perceptible in the morning, when the dew is on the grass. It is called the moschatel, or gloryless (*Adoxa moschatellina*). If you note down the flowers of the month, you will be able to gather the sweet violet (*Viola odorata*), and the dark brown or yellow wallflower (*Cheiranthus cheiri*), that

"To me more pleasure yields,
Than all the pomp imperial domes display."

We must not forget the early blooming Peristemon (*Peristemon campanulata*), with its elegant purple bells; the common arum (*Arum maculatum*), called by the million, wakerobin, cuckoo pint, lords and ladies, &c.; nor the dove's foot cranes-bill (*Geranium molle*), which the French call *pie de pigeon*. 'Tis a pretty flower, with its round velvety leaves, and deep rose-coloured bells.

Come and take a peep. Look through the primrose (*Primula vulgaris*) tufts, on yonder bank, where the sky-blue periwinkle (*Vinca major*), hangs in elegant wreaths, or climbs the aged trees. No wonder it is regarded as an emblem of "sweet remembrances."

Yonder is the cornelian cherry (*Cornus mascula*); the dwarf almond (*A. nana*); the Japan plum (*Prunus Japonica*); the blackthorn (*P. spinosa*); the hazel (*Corylus avellana*); the alder (*Alnus glutinosa*); and the weeping willow (*Salix Babylonica*). We had nearly overlooked

"The coy anemone that ne'er uncloses
Her leaves until they're blown on by the wind."

but their bright flowers have reminded us of our apparent negligence, yet amid such a variety of tree, shrub, and flower, we are most bewildered. However, here is the gay poppy anemone (*Anemone coronaria*); the wood anemone (*A. nemorosa*); the

garden anemone (*A. hortensis*); and the star anemone (*A. stellata*).

Hark! that is the song of the blackbird (*Merula torquata*) ushering in Spring, with its gay flowers, and he is joined by the ring-dove (*Columba palumbus*); and the magpie (*Pica caudata*).

What a variety of birds are around us! and many of them different from those we shall see or have seen during other months. There is the jay (*Garrulus glandarius*); the marsh tit (*Parus palustris*); the green woodpecker (*Picus viridis*); the jack-daw (*Corvus monedula*); the pied wagtail (*Motacilla lotor*); the wheat-ear (*Saxicola oenanthe*); the turkey-cock (*Meleagris gallopavo*); and the red wing (*Turdus iliacus*). Epicures regard the widgeon (*Mareca Penelope*); the teal (*Querquedula crecca*); the woodcock (*Scolopax rusticola*); the snipe (*S. gallinago*); and the Jack snipe (*S. gallinula*), with great interest. There are other birds abroad, some about to take their departure to other parts, and others just arriving among us; such as the hooded crow (*Corvus cornix*); the turnstone (*Streptilas collaris*); the gannet (*Sula alba*); the merlin (*Falco Æsalon*); and the chiff-chaff (*Sylvia hyppolais*).

The fish of the month are the pike (*Esox lucius*); the roach (*Leuciscus rutilus*); and the smelt (*Osmerus eperlanus*); but as they all spawn during the month they are not fit for food.

The chief insects are the red admiral butterfly (*Vanessa Atalanta*); the tortoiseshell butterfly (*V. urticae*); the peacock butterfly (*V. Io*); and the dotted border-moth (*Lampetia stictaria*); the orange under-wing moth (*Brepha Parthenias*); the oak beauty moth (*Biston prodomarius*); the pill beetle (*Byrrhus Piluta*); and the 22-spot lady bird (*Coccinella 22-punctata*).

The quadrupeds of the month are the sneaking dormouse (*Myoxus avellanarius*); the gambolling squirrel (*Sciurus vulgaris*); and the injured hedgehog (*Erinaceus Europæus*).

The reptiles are the loathsome toad (*Bufo communis*); and the common viper (*Vipera communis*).

At this period of the year, Nature begins to wear a reviving aspect after the severe reign of winter. It is like hope to the sorrowing heart after the first stroke of affliction.

NATURAL PHILOSOPHY.

CHAPTER XVIII.

GRAVITATION.—(Continued from page 158.)

Preliminary Ideas of Motions of Attraction.—The Earth and Falling Bodies.—Laws of Attraction, as respects Mass and Distance.—Nature of Weight.—Absolute and Specific Weight.—The Plumb-Line.—Convergence of such Lines towards the Earth's Centre.—Action of Mountain Masses.

ALL material substances exert upon each other an attractive force. To this the designation of Gravity or Gravitation has been given. It was the great discovery of Sir Isaac Newton, that the same force which produces the descent of a stone to the ground holds together the planets and other celestial bodies.

To obtain a preliminary idea of the nature and operation of this force, let us suppose that two balls of equal weight be placed in presence of each other, and under such circumstances that no extraneous agency supervenes to interfere with their mutual action. Under these circumstances, all the phenomena of Nature prove that the two balls will commence moving toward each other with equal speed, their velocity continually increasing until they come in contact. Inasmuch, therefore, as their masses are equal and their velocities equal, the quantities of motion they respectively possess will also be equal, as is proved in Chapter XVII.

Again; let there be two other balls situated as before, but let one of them, B, be twice as large as A. Motion will again ensue by reason of their mutual attraction, and they will approach each other with a velocity continually increasing. In this instance, however, their speed will not be equal, the larger body, B, having a correspondingly less velocity than the smaller one, A. If, as we have supposed, it is twice as large, its velocity will be only one-half. But in this, as in the former case, the quantity of motion that each possesses is the same, for that depends on velocity and mass conjointly.

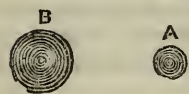


Fig. 91.

Further; if of the two bodies one becomes infinitely less as respects the other, then it is obvious that the little one alone will appear to move. This condition is what actually obtains in the case of our earth, and bodies subjected to its influence. A mass of any kind, the support of which is suddenly removed, falls at once to the ground, and though in reality the earth moves to meet it just as much as it moves to meet the earth, the difference in these masses is so immeasurably great that the earth's motion is imperceptible and may be wholly neglected.

The force by which bodies are thus solicited to move to the earth is called terrestrial gravity, or gravitation.

[Gravity is the reciprocal attraction of matter on matter; gravitation is the difference between gravity and the centrifugal force induced by the velocity of rotation or revolution.—“*Somerville's Connection of the Physical Sciences*, p. 437.”]

The force of gravity depends on two different conditions: 1st, the mass; 2nd, the distance.

1st. The intensity of the force of gravity is directly as the mass. That is to say, that, for example, in the case of the earth, if its mass were twice as large, its force of attraction would be twice as great; or if it were only half as large, its attraction would be only half as much as it is.

2nd. In common with all other central forces, gravity diminishes as the distance

increases. The law which determines this is expressed as follows:—"The force of gravity is inversely as the square of the distance:" that is to say, if a body be placed two, three, four, five times its original distance from another, the force attracting it will continually diminish, and in those different instances will successively be four, nine, sixteen, twenty-five times less than at first.

When a body, instead of being allowed to fall freely to the earth, is supported, its tendency to descend is not annihilated, but it exerts upon the supporting surface a degree of pressure. This pressure we speak of as **WEIGHT**. And inasmuch as the attractive force upon a body depends on its mass, it is obvious that if the mass is doubled, the weight is doubled; if the mass is tripled, the weight is tripled. Or, in other words, the weight of bodies is always proportional to their mass.

The absolute weight of a given body at the same place on the earth's surface is always the same; for the mass, and therefore the attractive force of the earth, never changes. If by any means the attractive influence of the earth could be doubled, the weight of every object would change, and be doubled correspondingly.

The absolute weight of bodies is determined by balances, springs, steelyards, and other such contrivances, as will be explained in their proper place. Different units of weight are adopted in different countries, and for different purposes, as the grain, ounce, pound, gramme, &c.

In bodies of the same nature the absolute weight is proportional to the volume. Thus a mass of iron which is twice the volume of another mass will also have twice its weight.

But when we examine dissimilar bodies, the result is very different. A globe of water compared with one of copper, or lead, or wood of *the same size*, will have a very different weight. The lead will weigh more than the water, and the wood less.

This fact we have already pointed out by the term "*specific gravity*," or specific weight of bodies. And, inasmuch as it is obviously a relative thing, or a matter of comparison, it is necessary to select some substance which shall serve to compare other bodies with: for solids and liquids, water is taken as the unit or standard of comparison. And we say that iron is about seven, lead eleven, quicksilver thirteen times as heavy as it; or that they have specific gravities expressed by those numbers. The unit of comparison for gaseous and vaporous bodies is atmospheric air.

When an unsupported body is allowed to fall, its path is in a vertical line. If a body be suspended by a thread, the thread represents the path in which that body would have moved. It occupies a vertical direction, or is perpendicular to the position which would be occupied by a surface of stagnant water. Such a thread is termed a **plumb-line**. It is of constant use in the arts to determine horizontal and vertical lines.

If in two positions, A B, Fig. 92, on the earth's surface plumb-lines were suspended,

it would be found that, though they are perpendicular as respects that surface, they are not parallel to one another, but incline, at a small angle, A C B, to each other. If their distance be one mile, this convergence would amount to one minute; and if it be sixty miles, the convergence will be one degree. Now, as the plumb-line indicates the path of a falling body, it is easily understood that on different parts of the earth's surface the paths of falling bodies have the inclinations just described. A little consideration shows that the descent of such bodies is in a line directed to the centre, C, of the earth.

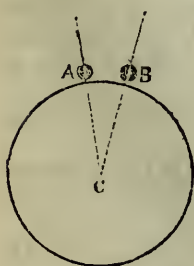


Fig. 92.

That centre we may therefore regard as the active point, or seat of the whole earth's attractive influence.

When examinations with plumb-lines are made in the neighbourhood of mountain masses, those masses exert a disturbing agency on the plummet, drawing the line from its true vertical position. But this is nothing more than what ought to take place on the theory of universal gravitation; for that theory asserting that all masses exert an attractive influence, the results here pointed out must necessarily ensue, and the latera action of the mountains correspondingly draw the plummet aside.

CHAPTER XIX.

THE DESCENT OF FALLING BODIES.

Accelerated Motion.—Different bodies fall with equal velocities.—Laws of Descent as respects Velocities, Spaces, Times.—Principle of Atwood's Machine.—It verifies the laws of Descent—Resistance of the Atmosphere.

OBSERVATION proves that the force with which a falling body descends depends upon the distance through which it has passed. A given weight falling through a space of an inch or two may give rise to insignificant results: but if it has passed through many yards those results become correspondingly greater.

Gravity being a force continually in operation, a falling body must be under its influence during the whole period of its descent. The soliciting action does not take effect at the first moment of motion and then cease, but it continues all the time, exerting, as it were, a cumulative effect. The falling body may be regarded as incessantly receiving a rapidly-recurring series of impulses, all tending to drive it in the same direction. The effect of each one is, therefore, added to those of all its predecessors, and a uniformly accelerated motion is the result.

Falling bodies are, therefore, said to descend with a uniformly accelerated motion.

As the attraction of the earth operates with equal intensity on all bodies, all bodies must fall with equal velocities. A superficial consideration might lead to the erroneous conclusion that a heavy body ought to descend more quickly than a lighter. But if we have two equal masses, apart from each other, falling freely to the ground, they will evidently make their descent in equal times or with the same velocity. Nor will it alter the case at all if we imagine them to be connected with each other by an inflexible line. That line can in no manner increase or diminish their time of descent.

The space through which a body falls in one second of time varies to a small extent in different latitudes. It is, however, usually estimated at sixteen feet and one-tenth.

As the effect of gravity is to produce a uniformly accelerated motion, the final velocities of a descending body will increase as the times increase; thus, at the end of two seconds, that velocity is twice as great as at one; at the end of three seconds three times as great; at the end of four, four times, and so on. Therefore the final velocity at the end

Of the first second is	.	.	.	$32\frac{1}{2}$ feet.
„ second „	.	.	.	$64\frac{2}{5}$ „
„ third „	.	.	.	$96\frac{3}{5}$ „
„ &c., „				&c.

The spaces through which the body descends in equal successive portions of time increase as the numbers 1.3.5.7, &c.; that is to say, as the body descends through sixteen feet and one tenth in the first second, the subsequent spaces will be

For the first second	.	.	.	$16\frac{1}{10}$ feet.
„ second „	.	.	.	$48\frac{3}{10}$ „
„ third „	.	.	.	$80\frac{5}{10}$ „
„ &c.,				&c.

and these numbers are evidently as 1.3.5, &c.

The entire space through which a body falls increases as the squares of the times. Thus, the entire space is,

For the first second	.	.	.	$16\frac{1}{10}$ feet.
„ second „	.	.	.	$64\frac{2}{5}$ „
„ third „	.	.	.	$144\frac{9}{10}$ „
„ &c.,				&c.

and these numbers are evidently as 1.4.9, &c., which are themselves the squares of the numbers 1. 2. 3, &c.

If a body continued falling with the final velocity it had acquired after falling a given time, and the operation of gravity were then suspended, it would descend

in the same length of time through twice the space it fell through before relieved from the action of gravity.

The following Table embodies the results of the three first laws.

Times	1.2.3.4.5.6.7, &c.
Final velocities	2.4.6.8.10.12.14, &c.
Space for each time	1.3.5.7.9.11.13, &c.
Whole spaces	1.4.9.16.25.36.49, &c.

It would not be easy to confirm these results by experiments directly made on falling bodies, the space described in the first second being so great (more than sixteen feet), and the spaces increasing as the squares of the times. There is an instrument, however, known as Attwood's machine, in which the force of gravity being moderated without any change in its essential characters, we are enabled to verify the foregoing laws.

The principle of Attwood's machine is this. Over a pulley, A, Fig. 93, let there pass a fine silk line which suspends at its extremities equal weights, *b* *c*. These weights, being equally acted upon by gravity, will, of course, have no disposition to move; but now to one of the weights, *c*, let there be added another much smaller weight; these conjointly preponderating over *b*, will descend, *b* at the same time rising. It might be supposed that the small additional weight, under these circumstances, would fall as fast as if it were unsupported in the air; but we must not forget that it has simultaneously to bring down with it the weight to which it is attached, and also to lift the opposite one. By its gravity, therefore, it does descend, but with a velocity which is less in proportion as the difference between the two weights to which it is affixed is less than their sum. It gives us a force precisely like gravity—indeed it is gravity itself—operating under such conditions as to allow a moderate velocity.

To avoid friction of the axle of the pulley, each of its ends rests upon two friction-wheels, as is shown at Q, Fig. 94; P is the pillar which supports the pulley. One of the weights is seen at *b*, the other moves in front of the divided scale, *c* *d*. This last weight is made to preponderate by means of a rod. There is a shelf which can be screwed opposite any of the divisions of the scale, and the arrival of the descending weight at that point is indicated by the sound arising from its striking. A clock, R, indicates the time which has elapsed. To enable us to fulfil the condition of suspending the action of gravity at any moment, a shelf, in the form of a ring, is screwed upon the scale at the point required. Through this the descending weight can freely pass, but the rod which caused the preponderance is intercepted. The equality of the two weights is, therefore, reassumed, and the action of gravity virtually suspended.

By this machine it may be shown that, in order that the descending weight shall strike the ring at intervals of 1, 2, 3, 4, &c., seconds, counting from the time at which its fall commences, the ring must be placed at distances from the zero of the scale, which are as the numbers 1, 4, 9, 16, &c.; and these are the squares of the times. And in the same manner may the other laws of the falling of bodies be proved.

[Galileo himself made experiments regarding the free descent of bodies, which were subsequently repeated by Piccioli and Grimaldi from the tower of Degli Asinelli in

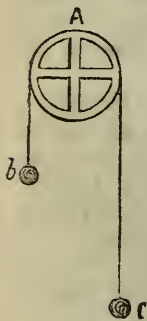


Fig. 93.

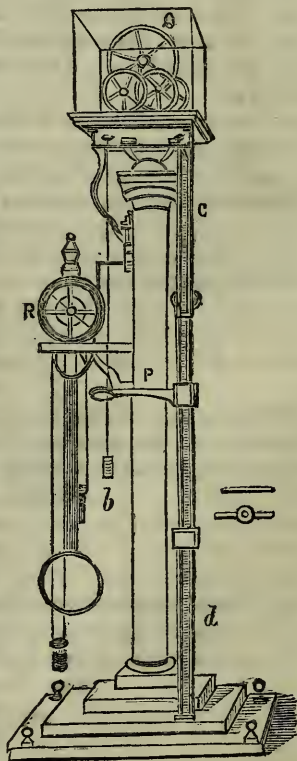


Fig. 94.

Bologna. Dechalles has, however, made the most accurate observations on the subject. The spaces through which bodies fall are always smaller than we might be led to expect from theory. This difference depends, however, solely upon the resistance of the, air which increases in accordance with the square of the velocity. In the *falling-machine* of Attwood, and the falling-channel, the resistance of the air does not influence the results."—*Professor Müller on Physics and Meteorology, Lecture 10.*

When a body is thrown vertically upward, it rises with an equably retarded motion, losing $32\frac{1}{2}$ feet of its original velocity every second. If in vacuo, it would occupy as much time in rising as in falling to acquire its original velocity, and the time expended in the ascent and descent would be the same.

Forces which, like gravity, in this instance produce a retardation of motion, are nevertheless designated as accelerating forces. Their action is such that, if it were brought to bear on a body at rest, it would give rise to an accelerated motion.

In rapid movements taking place in the atmosphere, a disturbing agency arises in the resistance of the air—a disturbance which becomes the more striking as the descending body is lighter, or exposes more surface. If a piece of gold and a feather are suffered to drop from a certain height, the gold reaches the ground much sooner than the feather. Thus, if in a tall air-pump receiver we allow, by turning the button, *a*, Fig. 95, a gold coin and a feather to drop, the feather occupies much longer than the coin in effecting its descent; and that this is due to the resistance of the air is proved by withdrawing the air from the receiver, and, when a good vacuum is obtained, making the coin and the feather fall again. It will now be found that they descend in the same time precisely, as shown in the above diagram.

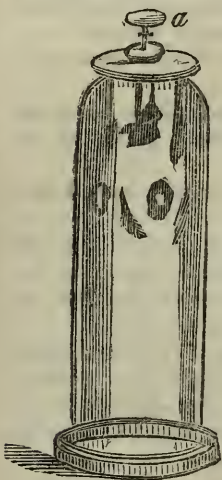


Fig. 95.

Nor is it alone light bodies which are subject to this disturbance: it is common to all. Thus, it was found that a ball of lead, dropped from the dome of St. Paul's Cathedral, in London, occupied $4\frac{1}{2}$ seconds in reaching the pavement, the distance being 272 feet. But in that time it should have fallen 324 feet, the retardation being due to the resistance of the air.

It has been observed that the force of gravity is not the same on all parts of the earth. The distance fallen through in one second at the pole is 16.12 feet; but at the equator it is 16.01 feet. This arises from the circumstance that the earth is not a perfect sphere, its polar diameter being shorter than its equatorial, and, therefore, bodies at the poles are nearer to its centre than they are at the equator. Thus, in Fig. 96, let N S represent the globe of the earth, N and S being the north and south poles, respectively. Owing to its polar being shorter than its equatorial diameter, bodies situated at different points on the surface may be at very different distances from the centre, and the force of gravity exerted upon them may be correspondingly very different.

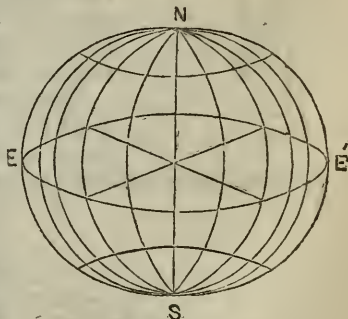


Fig. 96.

CHAPTER XX.

MOTION OF INCLINED PLANES.

Case of a Horizontal, a Vertical, and an Inclined Plane.—Weight expended partly in producing pressure and partly motion.—*Law of Descent down Inclined Planes.*—*Systems of Planes.*—*Ascent up Planes.*—*Parabolic theory of Projectiles.*—*Disturbing agency of the Atmosphere.*—*Resistance to Cannon shot.*—*Ricochet.*—*Ballistic Pendulum.*

WHEN a spherical body is placed on a plane set horizontally, its whole gravitation

is expended in producing a pressure on that plane. If the plane is set in a vertical position the body no longer presses upon it, but descends vertically and unresisted. At all intermediate positions which may be given to the plane the absolute attraction will be partly expended in producing a pressure upon that plane, and partly in producing an accelerated descent. The quantities of force thus relatively expended in producing the pressure and the motion will vary with the inclination of the plane: that portion producing pressure increasing as the plane becomes more horizontal, and that producing motion increasing as the plane becomes more vertical.

Let there be a ball descending on the surface of an inclined plane, A B, Fig. 97, and let the line, $d e$, represent its weight or absolute gravity. By the parallelogram of forces we may decompose this into two other forces, $d f$, and $d g$, one of which is perpendicular to the plane, and the other parallel to it. The first, therefore, is expended in producing pressure upon the plane, and the second in producing motion down it.

The following are the laws of the descent of bodies down inclined planes:

The pressure on the inclined plane is to the weight of the body at the base, B C, of the inclined plane is to its length, A B.

The accelerated motion of a descending body is to that which it would have had if it fell freely as the height, A C, of the plane is to its length, A B.

The final velocity which the descending body acquires is equal to that which it would have had if it had fallen freely through a distance equal to the height of the plane; and, therefore, the velocities acquired on planes of equal heights but unequal inclinations, are equal.

[It matters little what may be the inclination of the plane along which a body moves; the force must be calculated in the same manner; *i. e.* by the parallelogram of forces. For example, suppose that the plane was very oblique as E F, in Fig. 98, then we should say that the line, D C, was almost equal to the line D B; and hence that the force of the ball, D, moving on the inclined plane, E F, would differ very little from the force of the same body falling through air, and unobstructed, otherwise by the resistance of the atmosphere.—W. T. K.]

The space passed through by a body falling freely is to that gone over an inclined plane, in equal times, as the length of the plane is to its height.

[Galileo made several experiments with the inclined plane for the purpose of determining if the laws of falling bodies were correct. It is easy to see for ourselves, and therefore we will try an experiment with Galileo's inclined plane. Here is a narrow channel of wood, $a b$, which is made for the purpose of trying this experiment, having its inside made perfectly smooth; it is twelve feet long, and divided into feet and inches on the inside, and marked so that



Fig. 98.

Fig. 99.

any person can readily distinguish the figures. Let us place one end, b , upon some stones, $c d$, so as to raise it above the other end, a . We will now place a ball in the channel, at the upper part, b , and you will see that when it is liberated, it will roll rapidly down the channel, and also that the spaces traversed in 1, 2, 3, and its seconds, are as the squares of the time necessary to traverse the spaces. By this experiment we learn what are the true laws of gravitation, and discover that gravity is an uniform accelerating force.—W. T. K.]

If a series of inclined planes be represented, in position and length, by the chords of a circle terminating at the extremity of the vertical diameter, the times of descent down each will be equal, and also equal to the time of descent through that vertical diameter. Thus, let $A D$, $A G$, $D B$, $G B$, be chords of a circle terminating at the extremities, $A B$, of the vertical diameter; and regarding these as inclined planes, a body will descend from A to D , or A to G , or D to B , or G to B in the same time that it would fall from A to B .

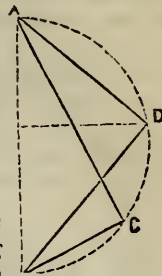


Fig. 100.

If a body descend down a system of several planes, $A C$, Fig. 101, with different inclinations, it would acquire the same velocity as it would have had in descending through the same vertical height, $A B$, though the times of descent are unequal.

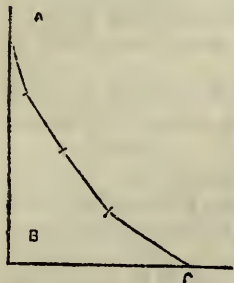


Fig. 101.

If a body which has descended an inclined plane meets at the foot of it a second plane of equal altitude, it will ascend this plane with the velocity acquired in coming down the first, until it has reached the same altitude from which it descended. Its velocity being now expended, it will re-descend, and ascend the first plane as before, oscillating down one plane up the other, and then back again. The same thing will take place if, instead of being over an inclined plane, the



Fig. 102.

motion be made over a curve, as in Fig. 102. In practice, however, the resistance of the air and friction soon bring these motions to an end.

In the motions of projectiles two forces are involved—the continuous action of gravity, and the momentary force which gave rise to the impulse—such as muscular exertion, the explosion of gunpowder, the action of a spring, &c.

The resulting effects of the combination of these forces will differ with the circumstances under which they act. If a body be projected downward, in a vertical line, it follows its ordinary course of descent, its accelerated motion arising from gravity being conjoined to the original projectile force. But if it be thrown vertically upward, the action of gravity is to produce an uniform retardation. Its velocity becomes less and less, until finally it wholly ceases. The body then descends by the action of the earth, the time of its descent being equal to that of its ascent, its final velocity being equal to its initial velocity.

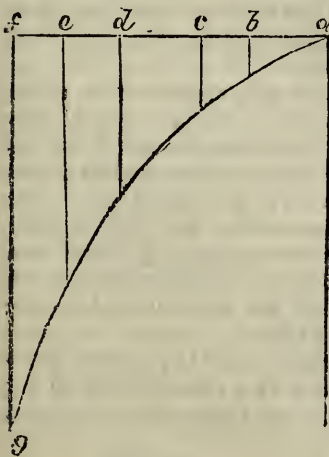


Fig. 103.

[If a body be thrown in any other than a vertical direction, it will describe a curved line, the form of which may be easily deduced from the laws of falling. Let us assume the simplest case: for instance, that the body be urged by any force in a horizontal direction. If there were no such force as gravity, the body would continually move in a horizontal direction and with an uniform velocity. By reason of the first impelling force, it would traverse the space, $a b$, in one second, the equally large space, $b c$, in two seconds, and so on, and must, consequently, at the end of the first, second, third, &c., seconds, have reached the points, $b c d$, &c. But it has sunk from the force of gravity: in the first second it fell 15 feet; consequently, at the end of that time, instead of being at b , it will be 15 feet below it. At the end of the next second, it is sixty feet below c ; at the end of the third, 135 feet below it, &c. The curved line, $a g$, described by the body in this manner, is a parabola.—*Professor Müller's Lectures, Lecture 10.*]

But if the projectile force forms any angle with the direction of gravity, the path

of the body is in a parabolic curve, as seen in Fig. 104. If the direction of the projection be horizontal, the path described will be half a parabola.

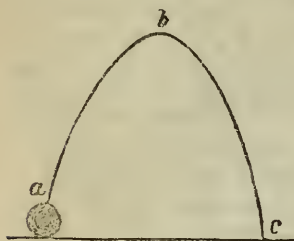


Fig. 104.

This, which passes under the title of the parabolic theory of projectiles, is found to be entirely departed from in practice. The curve described by shot thrown from guns is not a parabola, but another curve, the Ballistic. In vertical projections, instead of the times of ascent and descent being equal, the former is less. The final velocity is not the same as the initial, but less. Nor is the descending motion uniformly accelerated; but, after a certain point, it is constant. Analogous differences are discovered in angular projections.

The distance through which a projectile could go upon the parabolic theory, with an initial velocity of 2,000 feet per second, is about 24 miles; whereas no projectile has ever been thrown farther than five miles.

In reality, the parabolic theory of projectiles holds only for a vacuum. And the atmospheric air, exerting its resisting agency, totally changes all the phenomena—not only changing the path, but whatever may have been the initial velocity, bringing it speedily down below 1280 feet per second.

The cause of this phenomena may be understood from Fig. 105. Let B be a cannon-ball, moving from A to C with a velocity of more than 2000 feet per second. In its flight it removes a column of air between A and B, and as the air flows into a vacuum only at the rate of 1280 feet per second, the ball leaves a vacuum behind it. In the same manner it powerfully compresses the air in front. This, therefore, steadily presses it into the vacuum behind, or, in other words, retards it, and soon brings its velocity down to such a point that the ball moves no faster than the air moves—that is, 1280 feet per second.

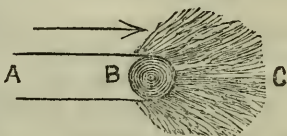


Fig. 105.

A shot, thrown with a high initial velocity, not only deviates from the parabolic path, but also to the right and left of it, perhaps several times. A ball striking on the earth or water at a small angle, bounds forward or *ricochets*, doing this again and again until its motion ceases.

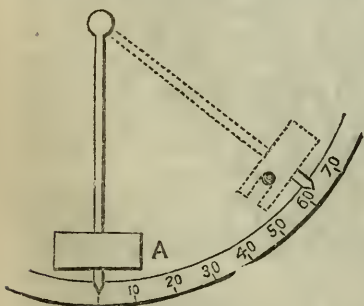


Fig. 106.

The initial velocity given by gunpowder to a ball, and, therefore, the explosive force of that material, may be determined by the Ballistic pendulum. This consists of a heavy mass, A, Fig. 106, suspended as a pendulum, so as to move over a graduated arc. Into this, at the centre of percussion, the ball is fired. The pendulum moves to a corresponding extent over the graduated arc, with a velocity which is less according as the weight of the ball and pendulum is greater than the weight of the ball alone.

The explosive force of gunpowder is equal to 2000 atmospheres. It expands with a velocity of 5000 feet per second, and can communicate to a ball a velocity of 2000 feet per second. The velocity is greater with long than short guns, because the influence of the powder on the ball is longer continued.

(To be continued.)

CHEMISTRY.

(Continued from page 163.)

Primary Forms.—The first class of primary forms includes the cube (fig. 26), the

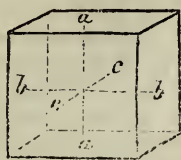


Fig. 26.

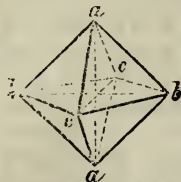


Fig. 27.

octahedron (fig. 27), and the dodecahedron (fig. 28). The faces of the cube are equal squares. The eight solid angles are similar, and also the twelve edges. The three axes are equal (aa , bb , cc), and connect the centres of opposite faces.

The regular octahedron (fig. 27), consists of two equal four-sided pyramids, placed base to base. The six solid angles are equal, and so also the edges, which, as in the cube, are twelve in number. The plane angles are 60° , and the interfacial $109^\circ 28' 16''$. The axes connect the opposite angles: they are equal, and intersect at right angles. This class is also called the *monometric* (*monos*, one, and *metron*, measure), the axes being equal.

The second class includes the square prism (fig. 29), and square octahedron (fig.

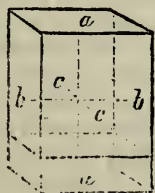


Fig. 29.

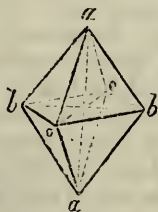


Fig. 30.

30). In the square prism (fig. 29), the eight solid angles are right angles, and similar, as in the cube. The eight basal edges are similar, but differ from the four lateral. The two basal faces are squares, the four lateral are parallelograms. The axes connect the centres of opposite faces, and intersect at

right angles. Square prisms vary in the length of the vertical axis (a , a), which is hence called the varying axis; the lateral axes (bb , cc) are equal. This class is also called the *dimetric* (*dis*, twofold, and *metron*, measure).

The third class contains the rhombic prism (fig. 31), the rectangular prism

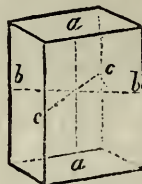


Fig. 31.

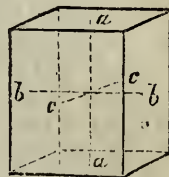


Fig. 32.

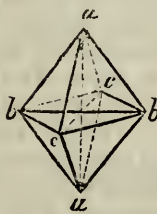


Fig. 33.

(fig. 32), and the rhombic octahedron (fig. 33). The rhombic prism (fig. 31) has two sorts of edges, two acute and two obtuse. The solid angles are, therefore, of two kinds, four obtuse and four acute. The axes are unequal, and cross at right angles.

The lateral connect the centres of opposite edges (bb , cc .) The basal faces are rhombic. The rectangular prism (fig. 32) has all its solid angles similar. There are three kinds or sets of edges, four lateral, four longer basal, and four shorter basal. The axes connect the centres of opposite faces, and intersect at right angles. The three are unequal. The rhombic octahedron (fig. 33), has three unequal axes, connecting opposite solid angles. All the sections in this solid are rhombic. This class is also called the *trimetric* (from *tris*, threefold, and *metron*, measure.)

The fourth class contains the oblique rhombic prism (fig. 34), and the right rhomboidal prism (fig. 35). The oblique rhombic prism is represented in the figure as inclining away



Fig. 34.



Fig. 35.

from the observer, the prism being in position when standing on its rhombic base. The upper and lower solid angles in front are dissimilar, one obtuse and the other acute. The four lateral solid angles are similar. Two of the lateral

edges are acute, and two obtuse; and the same is true of the basal. The lateral axes are unequal; they connect the centres of opposite lateral edges, and intersect at right angles. The vertical axis is oblique to one lateral axis, and perpendicular to the other. The right rhomboidal prism (fig. 35) has two obtuse and two acute lateral edges, and four longer and four shorter basal edges. The solid angles are of two kinds, four obtuse and four acute. The axes connect the centres of opposite faces; one is oblique, the others cross at right angles. This is also called the *monoclinite* (*monos*, one, and *clino*, to incline), having one inclined axis.

The fifth class includes the oblique rhomboidal prism. In this solid only those parts diagonally opposite are similar, and consequently it has six kinds of edges. The axes connect the centres of opposite faces. They are unequal, and all their intersections are oblique. This is called the *triclinite* class (from *tris*, three, and *clino*, to incline), the three axis all being obliquely inclined.

The sixth class includes the hexagonal prism (fig. 37), and the rhombohedron



Fig. 36.

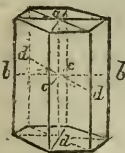


Fig. 37.

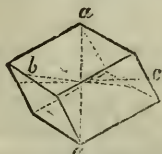


Fig. 38.

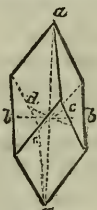


Fig. 39.

(figs. 38 and 39). The hexagonal prism has twelve similar angles, and the same number of similar basal edges. The lateral edges are six in number, and similar. The lateral edges are equal, and cross at 60° , connecting the centres of opposite lateral faces or lateral edges.

The rhombohedron is a solid whose six faces are all rhombs. The two diagonally opposite solid angles (*a a*) consist of three equal obtuse or equal acute plane angles, and the diagonal connecting these solid angles is called the vertical axis (*a a*). When the plane angles forming the vertical solid angles are obtuse, the rhombohedron is called an obtuse (fig. 38), and if acute, it is called an acute rhombohedron

(fig. 39). The three lateral axes are equal, and intersect at angles of 60° ; they connect the centres of opposite lateral edges. This will be seen on placing a rhombohedron in position and looking down upon it from above. The six lateral edges will be found to be arranged around the vertical axis, like the sides of a hexagonal prism.

The mutual relations of the primary forms are well shown in the foregoing arrangement. Thus, in each of the six classes, the first-named solid alone is, properly considered, a primary form, the others in each class being frequently found as secondaries to these. The six fundamental forms are the cube, square prism, right rectangular prism, oblique rhombic prism, or right rhomboidal prism, oblique rhomboidal prism, and the hexagonal prism, or rhombohedron.

Cleavage. — Common isinglass, or mica, will split into thin leaves or plates, which can be subdivided as long as our comparatively clumsy instruments will allow. This property depends on the crystalline structure of the mineral, and is called its *cleavage*. Many other minerals possess the same property. Thus, galena (sulphuret of lead), can be broken only into cubes, or in directions parallel to one or more of the faces of a cube. It differs from mica in having three cleavage directions, at right angles to each other. Fluor-spar, which is often found in cubes, can, by cleavage of the solid angles, be made into regular octahedrons. Calc-spar also admits of easy cleavage in three directions, but yields only rhombohedrons.

Cleavage is not effected with equal ease in all minerals: in mica, this is produced by the finger-nail; in others, a slight blow in the direction of the cleavage is required, and some practice and skill are necessary to ensure success. Quartz and several other minerals cleave only when heated and thrown into water; other minerals do not cleave at all. Cleavage, when attainable, takes place parallel to some or all of the faces of the primary form. It is obtained with equal ease or difficulty parallel to similar primary faces, and with unequal ease or difficulty parallel to dissimilar primary faces; and cleavage parallel to similar planes affords planes of similar lustre and appearance, and the converse.

Measurement of Crystals.—Common Goniometer.*—The angles of crystals are measured by means of instruments called

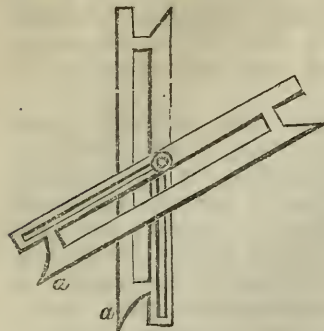


Fig. 40.

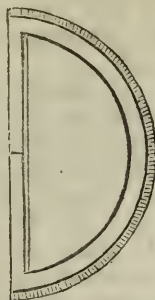


Fig. 41.

goniometers. The common goniometer, which is shown in figs. 40 and 41, consists of a light semicircle of brass, accurately graduated into degrees, and having a pair of steel arms moving on a central pivot, and so arranged as to slip in a groove over each other. The points *aa* can thus be made to embrace the faces of a crystal whose angle we wish to measure. When the edges of the sliding arms exactly fit the two faces containing the required angle, the screw which holds them together is tightened, and the graduated semicircle is applied with its centre at the point of intersection, when the angle is directly read on the arc, or its supplement is given in the alternate angles. By this instrument angles can be measured with only tolerable accuracy; but where the greatest nicety is required a much more delicate instrument is used.

Wollaston's Reflective Goniometer.—The

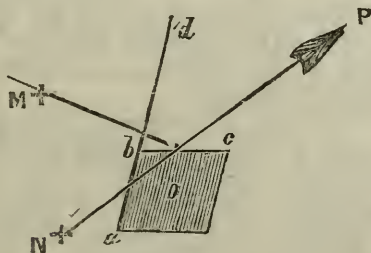


Fig. 42.

principle of this instrument may be understood by reference to fig. 42, which

* From the Greek *gonia*, an angle, and *metron*, a measure.

represents a crystal (*c*), whose angle (*abc*) is required. The eye at *P*, looking at the face (*bc*) of the crystal, observes a reflected image of *M*, in the direction *PN*. The crystal may now be so turned that the same image is seen reflected in the next face (*ba*), and in the same direction (*PN*). To effect this the crystal must be turned until *ab* has the present position of *bc*. The angle *dbc* measures, therefore, the number of degrees through which the crystal must be turned. But *dbc* subtracted from 180° equals the required angle of the crystal *abc*; consequently, the crystal passes through a number of degrees, which, subtracted from 180° , gives the required angle. When the crystal is attached to a graduated circle, which should move with it, we have the goniometer of Wollaston. In figure 43 there

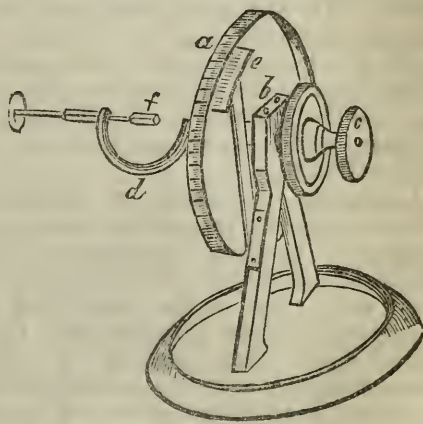


Fig. 43.

is shown such a circle of brass, *a*, graduated to half degrees, and hung by the axis *b*, on which it moves with great steadiness. This axis is perforated from end to end for the passage of a closely fitting rod or central axis, on one end of which is the bent joint (*d*), carrying the crystal (*f*). By the head *c*, and the arrangement at *d*, the crystal is adjusted without moving the graduated wheel; and when this is accomplished in such a manner that the eye of the observer placed over the crystal, as at *P* (fig. 43), can see a clear image of a line on the wall (*M*), or a window-bar in each face successively, then the graduated wheel (which stands, when at rest, at zero of the vernier (*e*) is made to revolve), and it the crystal,

until the mark or window-bar is distinctly seen in the second face. The number of degrees and parts of a degree which correspond to the angle required, are thus obtained directly by the movement of the wheel, which was beforehand placed with 180° opposite to the zero on the vernier. The movement of the wheel is, therefore, in fact, a subtraction of the angle $d b c$ from 180° . The great advantage of this instrument is, that we can by its aid obtain very precise results, and often on crystals too small to be held in the fingers and applied to a common goniometer. A small magnifier is sometimes attached to the instrument, to render it more complete.

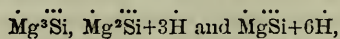
In measurements by the goniometer, a knowledge of the following simple principle in mathematics will be found of great value. "The sum of the three angles of a triangle equals 180° ," or "the sum of the angles of a polygon equals twice as many right angles as the polygon has sides, less two. If the figure has six sides, then it contains $2 + (6 - 2) = 8$ right angles, or $8 \times 90 = 720^\circ$."

Isomorphism.† — Identity of crystalline form was formerly supposed to indicate an identity of chemical composition. We now know that certain substances may replace each other in the constitution of compounds, without changing their crystalline form. This property is called *isomorphism*, and those bases which admit of mutual substitution are termed *isomorphous*. Chemistry furnishes us many examples of these isomorphous bodies. Thus alumina and peroxide of iron replace each other indefinitely. The carbonate of iron and carbonates of lime and magnesia are also examples, as the common sparry iron (*spathic iron*), which is a carbonate of iron, in which a large portion of carbonate of lime sometimes crystallizes, without producing any change of form in the mineral. Oxide of zinc and of magnesia, oxide of copper and protoxide of iron, also take the place each of the other in com-

pounds, without any alteration of crystalline form. When those bodies unite with acids to form salts, the resulting compounds have the same crystalline form, and if they have the same colour, are not to be distinguished from each other by the eye.

In double salts, like common alum, these relations are also found. The sulphate of iron may take the place of sulphate of alumina in common alum, and no change of form will occur; and soda may, in like manner, replace the potash. In fact, all the similar compounds or isomorphous bodies have a great resemblance to each other, in general appearance and chemical properties. The two bases in a double salt are, however, never taken from the same group of isomorphous bodies.

A knowledge of this law is of great importance to the chemist, and often enables him to explain, in a satisfactory manner, apparent contradictions and anomalies, and to decide many doubtful points. It is supposed that the elements whose compounds are isomorphous are also so themselves. M. Sheerer has noticed the curious and important fact, that in compounds containing magnesia, protoxide of iron, and other bases of the 6th family below, a part of the base may be wanting without a change of crystalline form, provided that this be replaced by a quantity of water which contains three times as much oxygen as this part of the base. For example, the compounds—



in accordance with this principle, are isomorphous. Thus, chrysolite and serpentine may be isomorphous, and much light is shed on the relations of hydrous and anhydrous minerals.

A more full discussion of this subject does not belong to our restricted limits, and we can only mention, in conclusion, the group of isomorphous bodies named by Professor Graham in his "Elements." 1st Family; Chlorine, Iodine, Bromine, Fluorine. 2nd Family; Sulphur, Selenium, Tellurium. 3rd Family; Phosphorus, Arsenic, Antimony. 4th Family; Barium, Strontium, Lead. 5th Family Silver, Sodium, Potassium, Ammonium. 6th Family; Magnesium, Manganese,

* The subject of crystallography cannot be further illustrated here; but the learner who desires to pursue it is referred to the highly philosophical treatise on Mineralogy by Mr. J. D. Dana, from which I have derived the substance of the foregoing.

† *Isos*, equal, and *morphe*, form.

Iron, Cobalt, Nickel, Zinc, Copper, Cadmium, Aluminium, Chromium, Calcium, Hydrogen.

*Dimorphism.**—Some substances have two forms, under both of which they are found. Thus common calcespar (carbonate of lime) generally occurs in rhombohedrons (figs. 38, 39), but in arragonite (which is only pure carbonate of lime), it is seen as a rhombic prism (fig. 31).

CHEMICAL EFFECTS OF VOLTAIC ELECTRICITY.

Electro-Chemical Decomposition.—In discussing the electricity of chemical action, allusion was made to the power possessed by this species of electricity to produce or modify chemical decomposition. Having now become somewhat familiar with the elementary constitution of matter, and the laws of chemical combination, we can the more intelligently proceed to a very brief review of the chemical effects of voltaic electricity.

Decomposition of Water.—Water was the first substance on which the decomposing power of the battery was observed, soon after the discoveries of Galvani and Volta were made known in England. When two gold or platinum wires are connected with the opposite ends of the battery, and held a short distance asunder in a cup of water, a train of gas-bubbles will be seen rising from each, and escaping from the surface of the water. With an arrangement of two glass tubes placed over the platinum poles, we can collect these bubbles as they rise.

Water is not only decomposed by the voltaic current, but that decomposition takes place in the proportions of the equivalents of the elements, and these elements seek opposite poles of the battery.

The experimental researches in electricity by Mr. Faraday, have shed much light on this subject; and his views being now generally adopted, it will be unnecessary for us to discuss the opinions formerly advanced by Volta, Davy, and others, which are very interesting and important in the history of the science, but do not now form part of its first principles. Mr. Faraday's researches required the introduction of certain new terms,

some of which we will now explain, as we shall find them more convenient than any others. The terminal wires or conductors of a battery are often termed the *poles*, as if they possessed some attractive power by which they draw bodies to themselves, as a magnet attracts iron. Mr. Faraday has shown that this notion is a mistake, and that the terminal wires act merely as a path or door to the currents, and he therefore calls them *electrodes*, from *electron*, amber, and *odos*, a way. The *electrodes* are any surfaces which convey an electric current into and out of a decomposable liquid. The term *electrolyses*, from *electron*, and the Greek verb *luo*, to unloose, is used to express decomposition; and the substances suffering decomposition are termed *electrolytes*.

Conditions of Electro-Chemical Decomposition.—1. All compounds are not electrolytes, that is, they are not directly decomposable by the voltaic current. Many bodies, however, not themselves electrolytes, are decomposed by a secondary action. Thus, nitric acid is decomposed in the electrical circuit by the secondary action of the nascent hydrogen, which, uniting with one equivalent of the oxygen, again forms water and nitrous acid. Sulphuric acid is not an electrolyte, while hydrochloric acid is; and the nascent chlorine from the latter attacks the electrode, if it be of gold. 2. Electrolysis cannot happen unless the fluid be a conductor of electricity; and no solid body, however good a conductor, has ever been thus decomposed. A plate of ice, however thin, interposed between the electrodes, will entirely prevent the passage of the power; but the electrolysis will proceed as soon as the least hole melts in the ice, through which the power can pass. Fluidity is therefore a very essential condition of electrolysis. The fluidity may be that of heat or of solution; thus, the chlorides of lead, silver, and tin, are not electrolysed in a solid state, but when fused they are decomposed with ease. 3. The ease of electro-chemical decomposition seems in a good degree proportioned to the conducting power of the fluid. Thus, pure water is by no means a good conductor, and its electrolysis is difficult; but the addition to it of a few drops of sulphuric acid, or of some other

* From *dis*, two, and *morphe*, form.

soluble conductor, greatly promotes the ease with which it is decomposed. 4. The amount of electrolysis is directly proportioned to the quantity of electricity which passes the electrodes. 5. The binary compounds of the elements, as a class, are the best electrolytes. Water and iodide of potassium are instances; while sulphuric acid, which has three equivalents of base to one of acid, is not an electrolyte. No two elements seem capable of forming more than one electrolyte.

6. A single ion, as bromine, for instance, has no disposition to pass to either of the electrodes, and the current has no effect upon it. There can be no electrolysis except when a separation of ions takes place, and the separated elements go one to each electrode. 7. There is no such thing, in fact, (as has been often supposed), as an actual transfer of ions from one part of the fluid to either electrode. In the case of water, for example, oxygen is given out on one side and hydrogen on the other. In order that this may be the case, there must be water between the electrodes. We cannot believe that the separation of the elements takes place at the electrode where one element is evolved, and the other travels over unseen to the opposite electrode. We may, however, conceive of water in its quiet state, as represented by Fig. 44,

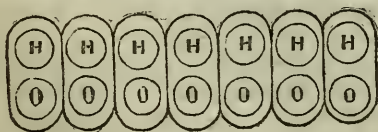


Fig. 44.

each molecule being firmly united by polar attractions to every other, and that the electrolytic force of the electric current has power to disturb this polar equilibrium, each molecule being similarly affected. In this case the electrolysis will proceed from particle to particle through the whole chain of affinities, decomposing and recomposing, until the ultimate particle on each side, having no polar force to neutralize it, escapes at that electrode which has a polarity opposite to itself. This explanation may be better understood, perhaps, by inspecting Fig. 45, which represents a series of compound mole-

cules of water undergoing electrolysis, the H and O being eliminated at the

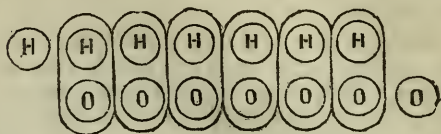


Fig. 45.

opposite extremities. The same explanation will be found to serve for all other cases of electrolysis, both simple and secondary.

8. A surface of water, and even of air, has been shown capable of acting as an electrode, proving that the contact of a metallic conductor with the decomposing fluid is not essential. The discharge from a powerful electrical machine was made to pass from a sharp point through air to a pointed piece of litmus-paper moistened with sulphate of soda, and then to a second piece of turmeric-paper similarly moistened. This discharge had power to effect a true electrolysis; the blue litmus was reddened by the sulphuric acid set free from the sulphate of soda, while the yellow turmeric was turned brown by the alkaline soda from the same salt.

Electrolysis takes place in a series of compounds in the precise order of their equivalents. Thus if wine-glasses are arranged in a series, and in one is placed sulphate of soda, in another acidulated water, in another iodide of potassium, and in another hydrochloric acid, and if the whole series be connected together by siphon tubes, or moistened lamp-wick, passing from glass to glass, and a powerful galvanic current be then passed through them, electrolysis will occur in all, but not in an equal degree.

It has been proved by accurate experiment, that the decomposition which ensues is in exact proportion to the equivalents of each substance. In other words, we say it requires one equivalent of electricity to decompose one equivalent of an electrolyte, formed from the union of an equivalent of acid and another of base. Conversely, from the fact that an equivalent of electricity is required to decompose any compound, it is proved that the opposite elements of this compound, in uniting, will disengage the same equivalent of electricity.

LESSONS IN FRENCH.

(Continued from page 166.)

THE ARTICLE.

Of cases in which a Noun, being used as the complement of a Verb, expresses with that Verb but one idea, which generally may be conveyed by one word.—When a noun is used with a verb and with that verb expresses but one idea, the article is dispensed with; as in,

Avoir	faim, soif,	to be hungry, thirsty,
	chaud,	warm, cold, &c.
	froid	
	dessein	to intend.
	compassion	to pity.
Chercher	honte	to be ashamed.
	coutume	to be in the habit.
	mal	to have pain.
	besoin	to want.
	envie, &c.	to wish, &c.
Courir	fortune	to seek fortune.
	malheur, &c.	to seek a quarrel.
	fortune	to run after fortune.
	risque	to risk.
	raison	to challenge.
Demander	vengeance	to ask for vengeance.
	justice,	to ask for justice, pardon.
	pardon	
	grâce, &c.	to supplicate.
	prise	to give one's enemy an advantage.
Donner	jour	to appoint a day.
	parole	to give word.
	avis, caution, &c.	to inform, to caution.
	belle	to make a narrow escape.
	raison	to hear reason.
Entendre	raillerie	to take a joke well.
	malice	to find out some wit in a throng.
	envie	to raise envy.
	réflexion	to reflect.
	honte	to disgrace one.
Faire	honneur	to do honour.
	peur	to affright.
	plaisir	to do a pleasure.
	gros	to make large profits.
	ordre (à ses affaires)	to settle (one's business).
Mettre	fin, &c.	to put a stop.
	raison	to talk reason.
	Français,	to speak French, English, &c.
	Anglais, &c.	
	envie	to envy.
Porter	bonheur	to bring good luck.
	malheur	to bring ill luck.
	garde	to take care.
	patience	to wait.
	médecine	to take some medicine.
Prendre	congé	to take leave.
	conseil, &c.	to consult somebody.
	service	to assist.
	visite	to pay a visit.
	vivre	to know how to live.
Rendre	parolo	to keep one's word.
Savoir		
Tenir		

But when the noun used with the verb as its complement, is qualified by an adjective, the adjective *a, un, une*, or the partitive word *some*, is most generally placed before that noun; as in, To have a terrible fright, *Avoir une terrible peur*; I am extremely hungry, *J'ai une faim extrême*; To reflect bitterly, *Faire des réflexions amères*; This brought me an extraordinary good luck, *Ceci me porta un bonheur extraordinaire*.

But when the adjective which qualifies the noun is the word *great, grand*, most generally the adjective *a un*, is suppressed; as, *J'ai grand faim*, I am very hungry; *J'ai grand peur*, I have a great fear.

Of Nouns employed as Apostrophes and Interjections.—When a noun is employed as an apostrophe or an interjection, the article *the* is dispensed with before that noun; as *Courage*, friend, defend yourself; *Courage, ami*, défendez-vous!

Of Nouns employed in Apposition or Adjectively.—When nouns change their primary signification into a qualification, or are used by apposition, the article is dispensed with; which may take place in different ways; as,

Are you surprised that Napoleon was more than a man in some of his acts? *Etes-vous surpris que Napoléon ait été plus qu'un homme dans plusieurs de ses actes?*

We see with delight the vast fields covered with golden harvests, the rich gifts of Ceres. *Nous voyons avec délices les vastes campagnes, couvertes de moissons dorées, riches dons de Cérès.*

In the first sentence, the word *homme* is taken adjectively; in the second, the phrase *riches dons* modifies *moissons dorées*, by apposition.

When they are used, at the beginning of an incidental sentence, elliptically; as,

All the nations of the globe have a notion, more or less clear, of a Supreme Being; an evident proof that original sin has not totally obscured our understanding. *Tous les peuples de la terre ont une idée plus ou moins juste d'un Etre Suprême; preuve évidente que la péché originel n'a pas tout-à-fait obscurci notre jugement.*

The ellipsis here consists in the omission of the words *which is*, before *evident proof*; which, if expressed, would be followed by *a, une*.

Of Nouns used as the objects of Nouns or Sorts, Kinds, or Species.—When a noun is used as the object of another noun expressing kind, sort, or species, it is pre-

ceded by the preposition *of*, *de*, and no article; as in, Do you like this kind of peaches? Aimez-vous cette espèce de pêches? I do not like this style of drawing. Je n'aime pas ce genre de dessin.

Remarks.—We must not mistake the above sentences for those in which taste and elegance alone cause the article to be suppressed, in order to give more rapidity and energy to the style; as,

Citizens, foreigners, enemies, people, kings, emperors, pity and respect him.	Citoyens, étrangers, ennemis, peuples, rois, empereurs, le plaignent et le respectent.
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There are many idiomatical and proverbial expressions which are constructed without the article, and would sound badly by its addition; but they prove nothing against the rule, and should be considered as the result of usage and habit only; as, Poverty is no vice, Pauvreté n'est pas vice, (standing for *la pauvreté n'est pas un vice*.) In which usage has suppressed *la* and *un*.

Of the Pronouns mon, ton, son, notre, votre, leur, ce, nul, aucun, quelque, chaque, tout (used for chaque), certain, plusieurs, and tel.—The article should not be placed before nouns preceded by the pronouns *mon, ton, son, notre, votre, leur, ce, nul, aucun, quelque, chaque, tout* (used for *chaque*), *certain, plusieurs* and *tel*; nor before a cardinal number taken absolutely; as, Twenty men fired at me, *Vingt hommes firent feu sur moi*. These pronouns and nouns of number exclude the article, because they all operate as the article would before the common nouns; they designate them in a precise manner, and give them the definite character which these nouns have in the mind of him who speaks.

But, if the cardinal numbers have a connection with what precedes or follows, they are no longer used in an absolute mode, and must be preceded by the article; as,

On the occasion of the miracle of the multiplication of loaves, the apostles said to (the) Christ: We have but five loaves and two fishes. Then Jesus Christ, taking the five loaves and the two fishes, blessed them, &c.	Dans le miracle de la multiplication des pains, les apôtres dirent au Christ: Nous n'avons que cinq pains et deux poissons. Alors Jesus Christ prenant les cinq pains et les deux poissons, les bénit.
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In the last part of this sentence, *cinq pains deux poissons* are connected with what precedes, and must be preceded by the article; whereas, in the first part they are not, and no article is used. Although the article *the* is never used with the possessive pronoun, and we cannot say, *La madame, les mesdames*, for *the lady* and *the ladies*, *la mademoiselle, les mes demoiselles*, for *the young lady* and *the young ladies*, we may very well say, *le monsieur* for *the gentleman*. The reason for this rule is, that in the two first expressions, the nouns *dame* and *demoiselle* being sometimes used by themselves, the words *madame* and *mademoiselle*, although spelled in one word, present two distinct ideas, and signify *my lady* and *my miss*; it is therefore evident that the expressions *the my lady* and *the my miss*, cannot be used, whilst in the word *monsieur*, the two words *mon* and *sieur* being inseparable, because the word *sieur* is no longer in use, except in court, those two words do not represent the two English words, *my sire*, but only recall to the mind the idea represented by the noun *gentleman*, which being but one word, may very well be preceded by the article.

Of Proper Names of Deities, Men, and Animals.—Proper names of deities, men, and animals, do not take the article, if they are not taken in a limited sense; as, God has made the world as it is, *Dieu a fait le monde comme il est*; Mars was the god of armies, *Mars était le dieu des armées*; Pegasus was the horse of the Parnassus, *Pégase était le cheval du Parnasse*.

But when those nouns are restricted in their meaning, they become common nouns applied to one or several individuals, and are used definitely; as, The God of Christians, *Le Dieu des Chrétiens*; The Mars of the Iliad, *Le Mars de l'Iliade*; The Pegasus of Apollo, *Le Pégase d'Apollon*. In the first examples, the words *Dieu, Mars, Pégase*, are used only for the sake of their signification. In the last, on the contrary, they are used with regard to the extent of that signification; hence, no article with the former, and the article with the latter.

Of the Article with some Italian and French Proper Names.—Sometimes, in imitation of the Italians, the French join the article to the names of painters, poets,

actors and actresses of that nation ; but they do it only by an elliptical mode of expression ; there is always a common noun understood ; so we say, *La Malaspine*, for *La Contessa Malaspine* ; *Le Tasse*, for *Il poeta Tasso*. Formerly, the same mode of expression was used with the name of some of our actresses with an idea of contempt or degradation ; it was then customary to say, *Mrs. Lemaure* sings like a nightingale, *La Lemaure* chante comme un rossignol ; That is a trick played by *Mrs. Gaussin*, *C'est un tour joué par La Gaussin*. But now, among well-bred people, this mode of expression is no longer in use, and would show a want of education in those who should employ it.

Of Nouns preceded by an Adverb, or an expression of Quantity.—The article is seldom used before a noun after an adverb or word of quantity, and that word of quantity is always itself followed by the preposition *of*, *de* ; as,

How many apples have you bought ? *Combien de pommes avez-vous acheté ?*
 He has as much courage as yourself. *Il a autant de courage que vous.*
 A multitude of persons were drowned. *Une multitude de personnes furent noyées.*

Exceptions.—*Bien*, as an adverb, *la plupart*, *la multiplicité*, are followed by the preposition *of*, and the article ; as,

Many people have perished. *Bien des gens ont péri.*
 She is very kind. *Elle a bien de la bonté.*
 Most men have no opinion of their own. *La plupart des hommes n'ont pas d'opinion à eux.*

Health yields to the number of remedies. *La santé cède à la multiplicité des remèdes.*

Plusieurs is followed by the noun without either preposition or article, when used as an adjective ; but when used as an adverb, it follows the general rule, and takes *de* after it ; as, Several of my friends, *Plusieurs de mes amis* ; Several persons have told me, *Plusieurs personnes m'en dit*. *Tout*, followed by a noun used definitely, requires that noun to be preceded by the definite article ; as, Everybody says that you are good, *Tout le monde dit que vous êtes bon*.

Remarks.—Among the words of quantity are placed *plus*, *moins*, *pas*, *point*, *jamais*, which are followed by *of*, *de*, without the article ; as,

He has more money than I. *Il a plus d'argent que moi.*

He has less good qualities than vices. *Il a moins de qualités que de vices.*

He has no fortune. *Il n'a pas ou point de fortune.*

He never has any money. *Il n'a jamais d'argent.*

It must be observed, that in the preceding sentences, where the article is not employed, the nouns which are deprived of it are only taken with regard to their signification, and not as to the extent of that signification ; but as we say, with the article,

How many of the apples you have bought have you still ? *Combien des pommes que vous avez achetées, avez-vous encore ?*

A great number of the persons who have been to sea have perished. *Un grand nombre des personnes qui se sont mises en mer ont péri.*

He has many of the qualities and vices of his father, &c. *Il a beaucoup des qualités et des vices de son père ;*

because, in these sentences, the words *pommes*, *personnes*, *qualités*, *vices*, are restricted by the propositions which follow them, and are consequently definite.

Of the Article, with names of Measure, Weight, and Purchase.—In English, the adjective *a* or *an* is placed before nouns of measure, weight, and purchase ; but in French, the article *le*, *la*, or *les* is used in its stead ; as,

Rye is sold for two shilling a bushel. *Le seigle se vend cinq-ante sous le boisseau.*

Sugar is worth five-pence a pound. *Le sucre vaut dix sous la livre.*

Cider costs one shilling a gallon. *Le cidre coûte un shilling le gallon.*

It is more than three shillings for the two bottles. *C'est plus de trois shillings les deux bouteilles.*

Remark.—When speaking of time, we say, He receives ten shillings a week. *Il reçoit dix shillings par semaine.* It would be a fault to say, *la semaine*.

Of the Expressions the more and the less when used together in English to form a Comparison.—The more I see your sister, the less I love her. When the adverbs *more* and *less*, preceded by the article, are repeated in English, to form a comparison, the article *the* is suppressed in French ; the above sentence should then be expressed as follows : *Plus je vois votre sœur, moins je l'aime.*

The suppression of the article arises from the fact that this sentence expresses comparison in a comparative and not in a superlative degree ; for it signifies, When

I see your sister more, I love her less. And we shall see, when speaking of the adjective, that the comparative does not admit of the article being ever placed before the comparative adverbs *more* and *less*.

Of the Article the used in Forming a Comparison in the Superlative Degree.—When the article *the* is used in English with the adverbs *more* and *less*, to form a comparison in the superlative degree, it is also expressed in French; as, Your sister is the most handsome and amiable woman I know, *Votre sœur est la plus belle et la plus aimable femme que je connaisse*. It is seen by this sentence, that not only the article *the* is employed to form a superlative, but it is repeated before each adjective used in that degree of comparison.

The Article the, with the Adverbs more, less, and best, is sometimes Variable and sometimes Invariable.

Of all the ladies who were at the funeral, your sister was the most distressed. *De toutes les dames qui étaient aux funérailles, votre sœur était la plus affligée.*
I have noticed that your sister never cries, even when she is the most distressed. *J'ai remarqué que votre sœur ne pleure jamais, même quand elle est la plus affligée.*

In the first sentence, there is a comparison established between the lady spoken of and others; the words *the lady* are understood after the verb *was*, or the noun *lady* after the participle *distressed*, which compels the agreement of the article; for the latter part of the sentence signifies, Your sister was *the lady* the most distressed, or the most distressed *lady*. In the second sentence, on the contrary, there is no comparison established between the lady spoken of and any other; there is no feminine noun understood, which should compel the agreement of the article; the expression *the most* signifies, in the highest degree: it modifies the participle *distressed*, which, having no number and no gender of its own, cannot transfer them to the article; and the latter part of this sentence might be transposed; as, When she is distressed *the most*, or in the highest degree.

Le plus le moins, le mieux, the most, the less, the best, are always invariable when they relate to a verb or an adverb, because then they form an adverbial expression; as,

Racine and Boileau are the poets who write the best, who express themselves the most nobly. *Racine et Boileau sont les poètes qui écrivent le mieux, qui s'expriment le plus noblement.*

Le mieux, le plus, refer to the verb *écrivirent* and to the adverb *noblement*, and not to Boileau and Racine.

Of the Repetition of the Article.—The article is repeated or not before two or more plural nouns, united by the conjunction *and, et*; when it is repeated, the expression of the sentence is more energetic; when it is suppressed, it is more rapid; as in,

The fathers and mothers of the children were at the head of the procession. *Les pères et les mères des enfants ouvraient la marche.*

The devotion of fathers and mothers for their children is natural. *Le dévouement des pères et mères pour leurs enfants est naturel.*

But when two or several nouns are in the singular or are not in the same number, the article is always repeated; as in,

The father and mother of that child are dead. *Le père et la mère de cet enfant sont morts.*

The president and judges were of the same opinion. *Le président et les juges furent de la même opinion.*

Of the Repetition of the Article, with Nouns united by the Conjunction or, ou.—When two nouns are united by *or, ou*, and they represent objects of a different nature, the article is repeated before each; as in, I will send you the brother or the sister of my wife, *Je vous enverrai le frère ou la sœur de ma femme*. But if the noun which follows the conjunction *or, ou*, is only the explanation of that which precedes it, the article is suppressed before the last; as in, The deputies or representatives of the people were elected for four years, *Les députés ou représentants du peuple étaient élus pour quatre ans*.

Of the Repetition of the Article, with two Adjectives united by the Conjunction and, et.—When the two adjectives serve to qualify the same noun, the article is not repeated before the second; as in,

How do you like the large and splendid apartment that we have seen this morning? *Comment trouvez-vous le grand et magnifique appartement que nous avons vu ce matin?*

There is but one apartment spoken of. But if two adjectives, on account of their signification, cannot qualify the same

noun, the sentence is then elliptical; there is a noun understood, and the article should be repeated before each adjective; as in, I have visited both the ancient and the new continent, *J'ai visité l'ancien et le nouveau continent*. There are two continents spoken of. We want red and white wine, *Nous voulons du vin rouge et du vin blanc*. Wine cannot be red and white; there are two different kinds of wine spoken of.

Of the Article with two Adjectives united by the Conjunction or, ou.—When a noun is preceded by two adjectives, united by *or, ou*, and expressing qualities of a different nature, the article is repeated before the second adjective; as in,

There are young people who stop growing after they are fourteen or fifteen years old. *Il y a des jeunes gens qui ne grandissent plus après la quatorzième ou la quinzième année.*

Good or bad treatment cannot tame the ferocity of the tiger. *Les bons ou les mauvais traitements ne peuvent adoucir la férocité du tigre.*

But when the adjectives are placed after the noun, the repetition of the article is a matter of taste; as in,

The sincere or false remorse of the king softened the fury of the people. *Les remords vrais ou faux du roi, adoucirent la fureur du peuple.*

Speaking of philosophers, we may say equally well, for the modern or ancient philosophers: *Les philosophes anciens ou modernes, ou les philosophes anciens ou les modernes.*

(To be continued.)

ANSWERS TO MATHEMATICAL PROBLEMS.—PAGE 170.

1.

Let $m:n$ express the given ratio; then, $m+n$: m : : the given dividing line: the base. ∴ the sum of the sides, and difference of the angles at the base, are given; which is elegantly constructed, Prob. 12, in Simpson's "Algebra."

2.

100s. : 110s. :: 45s. : $49\frac{1}{2}$ s. ; and 16s. — 14s. (2s.) 14s. :: 50s. — $49\frac{1}{2}$ s. ($\frac{1}{2}$ s.) : $3\frac{1}{2}$ s. ; hence, $49\frac{1}{2}$ s — $3\frac{1}{2}$ s. = 46s., the price per jacket to be received by B. in ready money; therefore, one jacket : 46s. :: 300 jackets : £690, the ready money which B. must receive of A to answer the problem.

THE FIRST VOYAGE UP THE HUDSON.

A new history of New York lately published in America, contains a curious and interesting account of the first voyage up the Hudson, the largest river of the State of New York, and which, as our readers no doubt know, is navigable by ships to Albany, 120 miles from its mouth. The whole course of the Hudson is 324 miles.

About the same time that Champlain was on his first expedition against the Iroquois, Henry Hudson, a mariner in the employ of the Dutch East India Company, was penetrating the Arctic regions in the vain search for a northern passage to India. With a small yacht or fly-boat, called the Crescent, manned by a mixed crew of Englishmen and Hollanders, he attempted to reach Nova Zembla; but being impeded by masses of ice, he changed the course of his vessel to the south-west, ran down the coast of Acadia, and on the 17th of July, 1609, anchored off the Bay of Penobscot. Finding a good harbour near by, he entered it the following day, and remained there a week, preparing a new foremast and mending the tattered sails. While he was thus engaged, a large concourse of natives arrived in two French shallops and in canoes, and proposed to traffic furs for such European commodities as he might have on board. Something or other soon occurring to elicit suspicion of their intentions, Hudson ordered a strict watch to be kept. The day before he left the harbour, having refitted his yacht, he sent out a boat with six men to capture one of the shallops, while twelve men, armed with muskets and light field-pieces, went ashore in a second boat, and, driving the savages from their huts, plundered them of all the valuables they contained.

Leaving at once the immediate scene of this outrage, Hudson glided out to the mouth of the harbour, from whence he set sail on the following day. Running down the coast, he rounded the promontory of Cape Cod, and, steering in a southerly direction, reached the Capes of Virginia on the 18th of August. Being driven out to sea for eight days by a succession of severe gales, he did not land and visit the colony of his countrymen, which he knew to

have been settled on the James River two years before ; but turning northward, discovered the Delaware Bay, examined its currents, soundings, and the aspect of the land ; and then, without going on shore, continued his course northwardly until the 2nd of September, when he came in sight of the highlands of Neversink, and entering the next day the southern waters of New York, anchored during the same afternoon within the harbour of Sandy Hook.

He was immediately visited by the natives, some of whom were clad loosely in pliant deer-skins, while others were dressed in furs, and wore mantles of feathers. They brought on board small supplies of maize and green tobacco, which they exchanged for trifles.

While remaining at anchor in this harbour, he sent a boat with five men to sound through the Narrows, and examine the nature of the country beyond. They found a fertile soil, covered with luxuriant grass and goodly trees, and adorned with such a profusion of wild flowers that the air was filled with their fragrance. As the boat, however, was returning, its small crew was suddenly assaulted by a number of Indians in two large canoes, and John Colman, one of Hudson's veteran seamen, shot with an arrow in the neck. Two others were also wounded, but not mortally. This sad accident is supposed to have arisen from the Indians having been suddenly surprised at the appearance of strange men within their waters, and not from any preconceived opinion on their part ; for as soon as they had discharged their arrows, they fled with great speed. Two days afterwards the traffic with the natives was resumed. But Hudson, a strict, stern, cautious man, was no longer willing to hazard the safety of his vessel and crew among a people of whose pacific intentions he began to entertain serious doubts. Weighing anchor, and passing through the narrows on the 11th of September, he entered New York Bay, "an excellent harbour for all winds," where he remained until the next afternoon. Having determined to avoid all intercourse, as far as it was possible, with the savages who resided on the island of Manhattan, he sailed up the great North River two leagues, and, on the 13th, proceeded with a light wind

and flood-tide as far as Phillipsburgh. Here he anchored for the night. The following day he continued his voyage, having on his left the Palisade rocks, presenting through a distance of thirty miles, unbroken save by the valley of the Nyack, a lofty perpendicular front, varying in altitude from three to seven hundred feet, while on his right he beheld the river bounded by a low undulating border, fringed with noble trees, whose foliage was just beginning to be tinted with the rich colours of autumn. Sailing onward, he saw the river gradually expand into a bay, contract again, and again expand, until in the distance before him it appeared to be abruptly shut in by a barrier of mountains. The bold heart of the mariner sank within him as he saw what seemed to him the termination of his voyage. At length he discovered a deep, narrow, winding river, up which he sailed until he came to West Point, where he dropped anchor, and waited until daylight for the further prosecution of his discovery. As soon as the mist of the morning had cleared away, he continued his voyage fifty miles further up the river, where, in full view of the Catskill mountains, he remained until the following evening, trafficking with the natives, "very loving people," who spoke the language of the Mohawks. Going with them on shore in one of their canoes, he was conducted to a house made of the bark of trees, exceedingly smooth, and well finished both within and without. Near the house he saw a quantity of corn and beans drying in the sun, sufficient to have freighted three ships. The Indians received their visitors with great hospitality, spread mats for them to seat themselves upon, and brought them some food, in wooden bowls painted red, while two men were despatched in search of game, who speedily returned with a brace of wild pigeons. A fat dog was also killed, and skinned with shells taken from the water. These preparations were made in expectation of Hudson and his companions remaining during the night ; but they determined to return on board their ship. Apprehensive that they had been influenced to this course through fear of their bows and arrows, the noble-hearted savages immediately broke them into pieces and threw them into the fire. But the pru-

dence of Hudson was proof against even this act of friendliness, and he persisted in taking his leave. Soon after, he proceeded up the river two leagues, when meeting with shoal water, he anchored off the flats opposite to which the city of Hudson now stands. Continuing on his course by short stretches, during the three following days, he reached, on the 19th of September, the vicinity of Albany, where he remained with his yacht, trafficking with the natives for provisions and furs, while the mate, with four men, ascended the river in a boat, and sounded the depth of the channel as far up as the junction of the Mohawk with the Hudson, or opposite the present town of Lansingburgh.

Hudson arrived at Schenectadea, now called Albany, about noon. The natives immediately came flocking on board, bringing with them grapes and pumpkins, together with otter and beaver skins, which they exchanged for hatchets, beads, knives, and other trifles.

Desirous of testing if any of the chiefs were disposed to be treacherous, Hudson resorted to the singular expedient of plying them freely with wine and strong liquors. Under the influence of these strange potations, they all grew exceedingly merry, and one of them became intoxicated. On beholding him stagger and fall, the natives became dumb from utter astonishment. They all hurried ashore in their canoes, and did not again return to the ship until noon of the next day, when, finding their chief perfectly restored, they were highly gratified. Renewing their visit in the afternoon, they brought with them presents of tobacco and beads; and sending for a platter of venison, caused Hudson to eat with them. When he had done so, they all departed except the old chief, who still remained on board in the hope of attaining another draught of that attractive but poisonous fire-water, the knowledge of which was thus first introduced to the Indians of New York.

The tradition of this scene of intoxication, on the arrival of the first ship, exists among the Iroquois Indians until this day. One relation transfers the locality from Albany to New York, and is as follows:—"A long time ago, before men with white skins had ever been seen, some Indians

fishing at a place where the sea widens, espied something at a distance moving upon the water. They hurried ashore, collected their neighbours, who together returned and viewed intensely this astonishing phenomenon. What it could be, baffled all conjecture. Some supposed it a large fish, or animal; others, that it was a very big house floating on the sea. Perceiving it moving toward land, the spectators concluded it would be proper to send runners in different directions to carry the news to their scattered chiefs, that they might send off for the immediate attendance of their warriors. These arriving in numbers to behold the sight, and perceiving that it was actually moving toward them, they conjectured that it must be a remarkably large house, in which the Manitto, or Great Spirit, was coming to visit them. They were much afraid, and yet under no apprehension that the Great Spirit would injure them. They worshipped him. The chiefs now assembled at York Island, and consulted in what manner they should receive their Manitto. Meat was prepared for a sacrifice. The women were directed to prepare the best of victuals. Idols or images were examined and put in order. A grand dance they thought would be pleasing, and, in addition to the sacrifice, might appease him if angry.

"The conjurors were also set to work to determine what this phenomenon portended, and what the result would be. To these, men, women, and children looked up for advice and protection. Utterly at a loss what to do, and distracted alternately by hope and fear, in their confusion a grand dance commenced. Meantime fresh runners arrived, declaring it to be a great house of various colours, and full of living creatures. It now appeared certain that it was their Manitto, probably bringing some new kind of game. Others, arriving, declared it positively to be full of people of different colour and dress from theirs, and that one in particular appeared clothed altogether in red. This then must be the Manitto. They were lost in admiration, and could not imagine what the vessel was, whence it came, or what all this portended.

"They are now hailed from the vessel in a language they could not understand.

They answer by a shout, or yell, in their way. The large canoe stops. A smaller canoe comes on shore with the red man in it; some stay by his canoe to guard it. The chiefs and wise men form a circle, into which the red man and two attendants approach. He salutes them with a friendly countenance, and they return the salute after their manner. They are amazed at their colour and dress, particularly with him, who, glittering in red, wore something—perhaps lace and buttons—they could not comprehend. He *must* be the Great Manitto, they thought; but why should he have a white skin?

“A large, elegant bottle is brought by one of the supposed Manitto’s servants, from which a liquid is poured into a small cup or glass, and handed to the Manitto. He drinks, has the glass refilled, and handed to the chief near him. He takes it, smells it, and passes it to the next, who does the same. The glass in this manner is passed round the circle, and is about to be returned to the red-clothed man, when one of them, a great warrior, harangues them on the impropriety of returning the cup unemptied. ‘It was handed to them,’ he said, ‘to drink out of as he had. To follow his example would please him; to reject it might provoke his wrath; and, if no one else would, he would drink it himself, let what would follow; for it was better for one even to die, than that a whole nation should be destroyed.’

“He then took the glass, smelled at it, again addressed them, bidding them adieu, and drank its whole contents. All eyes were now fixed upon him. He soon began to stagger. The women cried, supposing him in fits. He rolled on the ground. They bemoaned his fate; they thought him dying. He fell asleep. They at first thought he had expired, but soon perceived he still breathed. He awoke, jumped up, and declared he never felt more happy. He asked for more; and the whole assembly imitating him, became intoxicated.

“While this intoxication lasted, the whites confined themselves to their vessel; but when it ceased, the man with red clothes returned, and distributed beads, axes, hoes, and stockings. They soon became familiar, and conversed by signs. The whites made them understand that

they would now return home, but the next year they would visit them again with presents, and stay with them a while; but that as they could not live without eating, they should then want a little land to sow seeds, in order to raise herbs to put in their broth.

“Accordingly a vessel returned the season following, when they were much rejoiced to see each other; but the whites laughed when they saw the axes and the hoes hanging as ornaments to their breasts, and the stockings used as tobacco-pouches. The whites now put handles in the axes, and cut down trees before their eyes, and dug the ground, and showed them the use of the stockings. Here, they say, a general laugh ensued, to think they had remained ignorant of the use of these things, and had borne so long such heavy metal suspended round their necks. Familiarity daily increasing between them and the whites, the latter now proposed to stay with them, asking them only for so much land as the hide of a bullock, spread before them, could cover or encompass. They granted the request.

“The whites then took a knife, and beginning at one place on this hide, cut it into a rope not thicker than the finger of a little child. They then took the rope, drew it gently along in a circular form, and took in a large piece of ground. The Indians were surprised at their superior wit, but did not contend for a little ground as they had enough. They lived contentedly together for a long time, but the new comers from time to time asked for more land, which was readily obtained. And thus they gradually proceeded up the Mahicannituck, or Hudson River, until they began to believe they would want all their country, which proved eventually the case.”

Such is the interesting tradition of the Iroquois, of their earliest interviews with the whites, and the incidents which rendered those meetings memorable.

After having passed several days in friendly intercourse and profitable trade with the natives, Hudson, finding he could proceed no higher up the river in his vessel, set out on his return. His ship again grounding opposite the spot where the city of Hudson now stands, and also suffering detention for some days by reason

of adverse winds, he went ashore and explored the western bank of the river, where he found a rich soil, covered with goodly oak, walnut, chestnut, and cedar-trees, with abundance of slate for houses, "and other good stones."

On the 26th, he was visited by two canoes, in one of which came the old chief who had been intoxicated at Albany. He had descended the river thirty miles to testify his love, bringing with him another old man bearing strings of beads as a present. Hudson caused them, and the four women by whom they were accompanied, to dine with him. Two of the latter were young girls, some sixteen or seventeen years of age, who behaved themselves "very modestly." Dropping down the river on the 27th, he anchored on the 29th in the vicinity of Newburgh, of which he took particular notice, as a "pleasant place to build a town in." Here he remained bartering with the natives, until the afternoon of October 1st, when he sailed with a fair wind through the Highlands, and after descending the river seven leagues, the wind failing, he anchored at the mouth of Haverstraw Bay.

The Indians of the Highlands, whose chief village was in the vicinity of Anthony's Nose—a name which has been given to an elevated peak on the east side of the North or Hudson River—soon came crowding on board in great numbers. One of them, dissatisfied with the trifles he had received in payment for his furs, and desirous of displaying to his friends something of a different character, lurked in his canoe about the stern of the ship, for the purpose of carrying off some article or other from this wonderful floating structure.

Watching his opportunity, he clambered up the rudder, and entering the cabin window, stole a pillow and a few articles of wearing apparel. For this act, so venial in a poor ignorant savage, he was immediately shot down by the brutal mate. His companions, panic-stricken, took to flight. In an effort to recover the articles, another Indian had one of his hands cut off, and was drowned.

Leaving the scene of this disaster, Hudson continued on his way, stopped for the night off the mouth of Croton River, sailed again at daybreak, and

descending the river twenty-one miles, came to an anchor near the upper end of the Island of Manhattan.

Previous to exploring the great river which now bears his name, Hudson, perhaps in retaliation for the death of Colman, had made prisoners of two Manhattan Indians, designing to hold them either as hostages for the future pacific behaviour of their tribe, or with a view of carrying them to Europe. Opposite West Point, as he went up the river, these prisoners had escaped, and making their way back with all speed to their friends, collected a large party of armed warriors, who lay in wait for the return of the vessel in the neighbourhood of the inlet of Harlem River.

Near to this inlet the ship was now hove to. One of the savages who had escaped, accompanied by many others, came out in two canoes; but not being suffered to approach the vessel, they fell back near the stern, and discharged a volley of arrows at the crew. A fire was immediately returned from the vessel, by which two or three of the savages were killed. Finding the numbers on shore increasing, the ship was at once got under way. As it moved along, the main body of the Indians ran to the point upon which Fort Washington was subsequently erected, and continued the assault by another volley of arrows. The discharge from a cannon killing two of them, the rest fled into the woods; but a dozen of the boldest speedily returned, and entering a canoe, advanced resolutely against the ship. The cannon was fired a second time, and the ball, passing entirely through the canoe, killed one of the warriors. A fire from the deck about the same time, killing several others, the fight terminated with the loss of nine Indians. Hudson, soon after, descended to the mouth of the river, and on the 4th of October, put to sea, shaping his course south-east by east.

THE GOSPEL.—There is not a book on earth so favourable to all the kind and all the sublime affections, or so unfavourable to hatred and persecution, to tyranny, injustice, and every sort of malevolence, as the Gospel. It breathes nothing throughout but mercy, benevolence, and peace.—*Beattie.*

It rains, but still the sun shines, and,
lo! behold,

The finger of God hath touch'd the sky,
And the clouds, like a vanquish'd army, fly,
Leaving a rich, wide, azure bow,
O'erspanning the works of His hand below."

The name of this month, which is derived from the Latin word *Aperire* (to open), has reference to the season, for the earth opens her bosom, and sends forth her riches, and the young buds open under the influence of the April showers,—spring has really come, and the song of the skylark is heard everywhere, as it soars on high :

"Like a poet hidden
In the light of thought,
Singing hymns unbidden,
Till the world is wrought

To sympathy with hopes and fears it heeded
not."

Since the time of Numa Pompilius, this month has retained the same place in the calendar that it does now. Romulus assigned thirty days to the month, but Numa reduced it to twenty-nine days; however, Julius Cæsar restored it to its original length, which has not been altered since.

The Romans dedicated April to the goddess Venus.

The synonymes of the month are as follows; in Latin, *Aprilis*; French, *Avril*; Italian, *Aprile*; Portuguese, *Abril*; ancient Cornish, *Eprell*; and Saxon, *Oster-monath*, or Easter month. The reason the Saxons called it Easter month, is said by some to be in honour of one of their goddesses named *Eastre*, *Eostre*, or *Easter*, while others maintain that it was from the easterly winds which prevail.

Painters have represented this month by the figure of a young man (sometimes with, and sometimes without wings, at his shoulders), clothed in a green flowing mantle, adorned with garlands of myrtle and hawthorn, symbolical of the verdure of the fields, and holding violets and primroses in his left hand, while the right holds the sign of *Taurus*, or the Bull, in allusion to the sun entering that sign on the 19th of the month.

The beauties of this month have afforded ample materials for the poet's fancy,—and numberless passages might be quoted, in which all her charms are set forth, did space permit; but we shall content our-

selves with the old English distich, which has become the proverb of the month; viz.,

"April showers
Bring forth May flowers."

There are several remarkable days belonging to the month; but as the natural history will necessarily occupy a considerable space, we shall only give a brief notice of them.

THE FIRST DAY, is called ALL FOOLS' DAY.—The well-known practice of making persons go on some foolish errand, such as to inquire for "pigeon's milk," "strap oil," &c., or playing some practical joke upon them, has given rise to the name of All Fools' Day. The person so deceived is called an April fool in England, a gowk in Scotland, and *un poisson d'Avril* (an April fish) in France. This custom is said to be of Jewish origin, and begun from the mistake of Noah in sending the dove out of the ark before the water had abated, on the first of the month, among the Hebrews, which answers to our first of April. And to perpetuate this deliverance, it was thought proper, whoever forgot so remarkable a circumstance, to punish them by sending them upon some sleeveless errand, similar to that ineffectual message upon which the bird was sent by the patriarch.

On this day, in 1578, William Harvey, the illustrious discoverer of the circulation of the blood, and physician to James I. and Charles I., was born at Folkstone; and in 1596, the celebrated philosopher, mathematician, and metaphysician, Rene Descartes, was born at La Haye, in Tourain.

THE SECOND DAY.—In 1791, Honoré Gabriel de Riqueti, Count of Mirabeau, died, aged forty-two years. He has been styled the Alcibiades of the French revolution, and is well known as a brilliant orator and fluent writer. In 1801, Lord Nelson's victory at Copenhagen was obtained.

THE THIRD DAY.—In 1826, died Reginald Heber, Bishop of Calcutta,—the author of the following beautiful little poem :

A NIGHT THOUGHT.

Reflected on the lake, I love
To see the stars of evening glow,
So tranquil in the heavens above,
So restless in the waves below

Thus heavenly Hope is all serene,
But earthy Hope, how bright soe'er,
Still fluctuates o'er this changing scene,
As false and fleeting as 'tis fair.

THE FOURTH DAY is dedicated to *St. Ambrose*.—He composed the hymn known as the *Te Deum*, and also converted and baptized *St. Augustine*. He was born about the year 340, and was the son of the *Prætorian prefect of Gaul*.

On this day, in 1774, died the celebrated *Oliver Goldsmith*, at the age of forty-five. He was the author of several good comedies, and many miscellaneous pieces, tales, &c.; among which we may mention the "*Vicar of Wakefield*," the "*Traveller*," and the "*Deserted Village*."

THE FIFTH DAY.—In 1605, died *John Stow*, at the age of eighty. He was the author of several works relating to national antiquities, the most celebrated of which is his "*Survey of London*." In 1753, the *British Museum* was established. In 1811, *Robert Raikes*, of *Gloucester*, died, aged seventy-six. He was the originator of *Sunday-schools*, in 1780.

THE SIXTH DAY is *OLD LADY DAY*.—In 1348, *Laura de Noves* died. She is celebrated for having been beloved by *Petrarch*, and for having returned his passion with indifference; and in 1695, died *Dr. Richard Busby*, aged eighty-nine.

THE SEVENTH DAY.—In 1718 *Dr. Hugh Blair*, the celebrated divine, was born in *Edinburgh*.

THE EIGHTH DAY.—In 1492, *Lorenzo dei Medici* died, in the forty-fourth year of his age; and in 1811, *Napoleon Bonaparte* abdicated the throne of France, and was afterwards sent to the *Isle of Elba*.

THE NINTH DAY.—In 1626, *Francis Bacon* died at *Highgate*, in his sixty-sixth year; and in 1807, died *John Opie*, the celebrated painter.

THE TENTH DAY.—In 1583, *Hugo Grotius* was born at *Delft*. He wrote many works upon jurisprudence, history, literature, divinity, and poetry. His work upon jurisprudence, entitled "*De Jure Belli et Pacis*," is considered as a standard work, and has been translated in all the European languages. In 1752, died *William Cheselden*, the celebrated surgeon and anatomist, in his sixty-fourth year.

THE ELEVENTH DAY.—In 1713, the celebrated peace of *Utrecht* was concluded, and with it terminated the twelve years' war for the succession to the throne of *Spain*. In 1770, *George Canning*, the distinguished statesman, was born, in the parish of *Marylebone, London*.

THE TWELFTH DAY.—In 65, the illustrious *Seneca* died at *Rome*, in the fifty-third year of his age. In 1704, *Jacques Benigne Bossuet* died at *Paris*, aged seventy-six. In 1748, *William Kent*, the artist and celebrated landscape gardener, died at the age of sixty-four. In 1765, died *Dr. Edward Young*, the author of "*Night Thoughts*," aged eighty-four. In 1782, *Pietro Metastasio*, the author of several sacred dramas or oratorios, especially "*La Mort d' Abel*," died, aged eighty-three; and in the same year *Admiral Rodney* defeated the French fleet, under *Count de Grasse*, in the *West Indies*.

THE THIRTEENTH DAY.—In 1759, died the celebrated *George Frederick Handel*, aged seventy-five,—one of the greatest musicians that ever lived. He composed "*Israel in Egypt*," "*The Messiah*," "*Judas Maccabæus*," and several other oratorios.

THE FOURTEENTH DAY.—In 1471, the battle of *Barnet* was fought, in the wars between the houses of *York* and *Lancaster*; when the *Earl of Warwick*, called the "*King Maker*," was slain in the field. In 1685, *Thomas Otway*, the dramatic poet, died before he had reached his thirty-fourth year; and in 1808, *Beilby Porteus*, the eminent divine, died at *Fullham*, in the seventy-eighth year of his age.

THE FIFTEENTH DAY.—In 1820, *John Bell*, the eminent surgeon and anatomist, died of dropsy at *Rome*, aged fifty-seven.

THE SIXTEENTH DAY.—In 1788, died *George Louis le Clerc, Comte de Buffon*, the celebrated naturalist, in his eighty-first year.

THE SEVENTEENTH DAY.—In 1790, *Benjamin Franklin*, the celebrated printer and philosopher, died at the age of eighty-four.

THE EIGHTEENTH DAY.—In 1552, *John Leland* or *Laylonde*, the eminent English antiquary, died; and in 1802, *Erasmus Darwin*, the celebrated physician and physiologist, died at *Derby* in the

seventieth year of his age. Darwin's "Zoonomia; or, Laws of Organic Life," and his "Phytologia; or, Philosophy of Agriculture and Gardening," were his best works.

THE NINETEEN DAY.—In 1560, Philip Melancthon or Melanthon, died at Wittenberg; and in 1824, Lord George Gordon Byron, died at Missolonghi, aged thirty-six.

THE TWENTIETH DAY.—In 1657, Blake destroyed the Spanish Armada; and in 1760, Jean Louis Petit, a celebrated French surgeon, died at Paris, aged eighty-six.

THE TWENTY-FIRST DAY is dedicated, in the old almanacks, to *St. Anselm*, who was born at Aoust in Piedmont, and created Archbishop of Canterbury in 1093, by William Rufus. He died on this day, 1109, aged seventy-six. In 1142, Peter Abelard, a learned doctor in the church, died, aged sixty-three. He was the celebrated lover of the no less celebrated Heloise. On this day, Bishop Heber was born, in 1783.

THE TWENTY-SECOND DAY.—In 1707, Henry Fielding, the novelist, or, as he is sometimes styled, "the father of the English novelists," was born; and in 1724, Emmanuel Kant, the author of the "Critical Philosophy," was born at Konigsberg in Prussia.

THE TWENTY-THIRD DAY is called *St. George's Day*.—*St. George* is the patron saint of England, and is said to have been born in Cappadocia of Christian parents. Every schoolboy has read the fabulous history of *St. George* rescuing the King of Beyrout's daughter from a desperate dragon, and all that befel him in his sojourn in Palestine. He is represented on our old sovereigns and five-shilling pieces, in the act of slaying the dragon. Historians agree that he was beheaded on this day 290, after being drawn through the city of Lydda, for having openly avowed himself as the champion of the Christians. *St. George* was the ancient word of attack of England, as *St. Andrew* was that of Scotland, and the figure of this saint is attached to the order of the Garter, which was instituted by Edward III. after the battle of Callice, in the year 1349.

In 1564, William Shakspeare, the immortal dramatist, is said to have been born; but there appears to be considerable doubt

as to the exact dates of his birth and death. The entry of his baptism in the register of baptisms of the parish church of Stratford-upon-Avon, is upon the 26th of April 1564, and the date of burial is registered as the 25th of April, 1616.

In 1616, the celebrated author of "Don Quixote," Miguel Cervantes de Saavedra, died at Madrid, aged sixty-nine.

THE TWENTY-FOURTH DAY.—In 1731, Daniel Defoe, the author of "Robinson Crusoe," "The Trueborn Englishman," &c., died in the parish of *St. Giles's*, Cripplegate, aged seventy.

THE TWENTY-FIFTH DAY is dedicated to *St. Mark*, whose Gospel was written in the year 63. The order of Knights at Venice, taking his name, was instituted in 737; their motto was "*Pax tibi, Marce, evangelista meus.*" There were many peculiar customs kept upon this day, but they have now become obsolete. Among others was that of blessing the corn, and also watching in the church porch on the eve of *St. Mark*, to see the ghosts of those who should die in the following year.

In 1595, Torquato Tasso died at Rome; and in 1599, Oliver Cromwell was born in Huntingdon. In 1800, William Cowper the poet died at East Dereham, near Norwich.

THE TWENTY-SIXTH DAY.—In 1711, David Hume, the historian, author of the "History of England," was born at Edinburgh; and in 1716, Lord John Somers died, aged sixty-four.

THE TWENTY-SEVENTH DAY.—In 1737, Edward Gibbon, the author of the "Decline and Fall of the Roman Empire," was born; and in 1794, Sir William Jones died in India, in his forty-eighth year.

THE TWENTY-EIGHTH DAY.—In 1825, died the Baron Denon, who was celebrated for his antiquarian researches.

THE TWENTY-NINTH DAY.—In 1779, the Rev. John Ash, LL.D., died at Pershore, in Worcestershire; and in 1759, William Pitt, the statesman, was born.

THE THIRTIETH DAY.—In 1745, the battle of Fontenoy was fought between the French under Count Saxe, and the English, Dutch, and Austrians, under the Duke of Cumberland. In 1789, General Washington was elected President of the United States; and in 1827 the first stone of the London University was laid.

HINTS TO TEACHERS.

BY D. PAGE.

III.—RIGHT MODES OF TEACHING.

FROM what has been said of education, it is very obvious that it is no small thing to be a successful teacher. It is admitted by all, that the teacher should be APT TO TEACH. He cannot be useful without this. He may have an unimpeachable character; he may have the most liberal and thorough literary acquirements; he may deeply feel his responsibility, and yet after all he may fail to teach successfully.

Aptness to teach has been said to be a native endowment, a sort of instinct, and therefore incapable of being improved by experience or instruction,—an instinct such as that which guides the robin, though hatched in an oven, to build a perfect nest like that of its parent, without ever having seen one. I am of opinion that such instincts in men are rare; but that aptness to teach, like aptness to do anything else, is usually an acquired power, based upon a correct knowledge of what is to be done, and some accurate estimate of the fitness of the means used for the end. If there are exceptions to this, they are very uncommon; and the safer way, therefore, for the majority of teachers, is, to study carefully the *rational* of their processes, and to rely rather upon sound and philosophical principles in their teaching, than upon a very doubtful intuition.

One of the most common errors into which young teachers fall (and some old ones too) is that of misjudging of the degree of assistance which the young scholar needs in the pursuit of learning. There are a few who forget the difficulties which impeded their own perception of new truths when learners, and therefore have no sympathy with the perplexities which surround the children under their charge when they encounter like difficulties. They refuse to lend a helping hand, even where it is needed; and by making light of the child's doubts, perhaps sneering at his unsuccessful struggles, they dishearten him so far that imaginary obstacles become insurmountable, and he gives up in despair. But a far more numerous class tend toward the other extreme.

From a mistaken kindness, or a mistaken estimate of the child's ability, or both, they are disposed to do quite too much for him, and thus they diminish his power to help himself. The child that is constantly dandled upon the lap of its nurse, and borne in her arms to whatever point it may desire to go, does not soon learn to walk; and when it at length makes the attempt, it moves not with the firm tread of him who was early taught to use his own limbs. There is a great deal of literary dandling practised in our schools; and, as a consequence, a great many of our children are mere sickly nurslings, relying upon leading-strings while in the school, and falling for very weakness, just as soon as the supporting hand is withdrawn. This evil is so common, and in some instances so monstrous, that I shall be pardoned if I dwell upon it a little more fully.

In illustrating this subject, I must mention two processes of teaching, not indeed exactly opposite to each other, though widely different,—into one or both of which many of our teachers are very liable to fall. I shall, for the sake of a name, designate the former as the *pouring-in process*. This consists in *lecturing* to a class of children upon every subject which occurs to the teacher, it being his chief aim to bring before them as many facts in a limited time as possible. It is as if he should provide himself with a basket of sweetmeats, and every time he should come within reach of a child, should seize him, and compel him to swallow—regardless of the condition of his stomach—whatever trash he should happen first to force into his mouth. Children are indeed fond of sweetmeats, but they do not like to have them *administered*,—and every physiologist knows there is such a thing as eating enough even of an agreeable thing to make one sick, and thus produce loathing for ever after. Now, many teachers are just such misguided caterers for the mind. They are ready to seize upon the *victims* of their kindness, force open their mental gullets, and pour in, without mercy and without discretion, whatever sweet thing they may have at hand, even though they surfeit and nauseate the poor sufferer. The mind, by this process, becomes a mere *passive recipient*, taking in without much

resistance whatever is presented till it is full.

"A passive recipient!" said one to his friend, "what is a *passive recipient*?" "A passive recipient," replied his friend, "is a *two-gallon jug*. It holds just two gallons, and as it is made of potters' ware, it can never hold but just two gallons." This is not an unfit illustration of what I mean by making the mind a passive recipient. Whenever the teacher does not first excite inquiry, first prepare the mind by *waking it up* to a desire to know, and if possible to find out by itself, but proceeds to think *for* the child, and to give him the results, before they are desired, or before they have been sought for,—he makes the mind of the child a *two-gallon jug*, into which he may pour just *two gallons*, but no more. And if day after day he should continue to pour in, day after day he may expect that what he pours in will *all run over*. The mind, so far as retention is concerned, will act like the jug; that is, a part of what is poured in to-day, will be diluted by a part of that which is forced in to-morrow, and that again will be partially displaced and partially mingled with the next day's pouring, till at length there will be nothing characteristic left. But aside from retention, there is a great difference between the jug and the mind. The former is inert material, and may be as good a jug after such use as before. But the mind suffers by every unsuccessful effort to retain.

This process of lecturing children into imbecility is altogether too frequently practised; and it is to be hoped, that intelligent teachers will pause and inquire before they pursue it further.

The other process to which I wish to call attention, is that which, for the sake of distinguishing it from the first, I shall denominate the *drawing-out process*. This consists in asking what the lawyers call *leading questions*. It is practised, usually, whenever the teacher desires to help along the pupil. This habit of assisting the pupil to some extent, is, however, a very common one, and as deleterious to mind as it is common. The teacher should at once abandon this practice, and require the scholar to *do the talking* at recitation. I need hardly suggest that such a course

of *extraction* at recitation, aside from the waste of time by both parties, and the waste of strength by the teacher, has a direct tendency to make the scholar miserably superficial. For why should he study, if he knows from constant experience that the teacher, by a leading question, will relieve him from all embarrassment? It has often been remarked, that "the teacher makes the school." Perhaps in no way can he more effectually make an inefficient school, than by this *drawing-out process*.

I look upon the two processes just described, as very prominent and prevalent faults in our modern teaching; and if by describing them thus fully, I shall induce any to set a guard upon their practice in this particular, I shall feel amply rewarded.

It is always a very difficult question for the teacher to settle, "How far shall I help the pupil, and how far shall the pupil be required to help himself?" The teaching of Nature would seem to indicate that the pupil should be taught mainly to depend on his own resources. This, too, I think, is the teaching of common sense. Whatever is learned should be so thoroughly learned, that the next and higher step may be comparatively easy. And the teacher should always inquire, when he is about to dismiss one subject, whether the class understand it so well that they can go on to the next. He may, indeed, sometimes give a word of suggestion during the preparation of a lesson, and by a seasonable hint, save the scholar the needless loss of much time. But it is a very great evil if the pupils acquire the habit of running to the teacher as soon as a slight difficulty presents itself, to request him to remove it. Some teachers, when this happens, will send the scholar to his seat with a reproof perhaps; while others, with a mistaken kindness, will answer the question, or solve the problem themselves, as the shortest way to get rid of it. Both these courses are, in general, wrong. The inquirer should never be frowned upon; this may discourage him. He should not be relieved from labour, as this will diminish his self-reliance without enlightening him; for whatever is done *for* a scholar without his having studied closely upon it himself, makes but a feeble impression upon him,

and is soon forgotten. The true way is, neither to discourage inquiry nor answer the question. Converse with the scholar a little as to the principles involved in the question; refer him to principles which he has before learned, or has now lost sight of; perhaps call his attention to some rule or explanation before given to the class; go just so far as to enlighten him a little, and *put him on the scent*, then leave him to achieve the victory himself. There is a great satisfaction in discovering a difficult thing for oneself, and the teacher does the scholar a lasting injury who takes this pleasure from him. The teacher should be simply suggestive, but should never take the glory of a victory from the scholar by doing his work for him, at least, not until he has given it a thorough trial himself.

The skill of the teacher, then, will be best manifested, if he can contrive to awaken such a spirit in the pupil, that he shall be very unwilling to be assisted; if he can kindle up such a zeal, that the pupil will prefer to try again and again before he will consent that the teacher shall interpose. I shall never forget a class of boys, some fourteen or fifteen years of age, who, in the study of algebra had imbibed this spirit. A difficult question had been before the class a day or two, when I suggested giving them some assistance. "*Not to-day, sir,*" was the spontaneous exclamation of nearly every one. Nor shall I forget the expression that beamed from the countenance of one of them, when, elated with his success, he forgot the proprieties of the school, and audibly exclaimed, "*I've got it! I've got it!*" It was a great day for him; he felt, as he never before had felt, his own might. Nor was it less gratifying to me to find that his fellows were still unwilling to know his method of solution. The next day a large number brought a solution of their own, each showing evidence of originality. A class that has once attained to a feeling like this, will go on to educate themselves, when they shall have left the school and the living teacher.

As to the communication of knowledge, aside from that immediately connected with school-studies, there is a more excellent way than that of *pouring it in* by the process already described. It

is but just that I should give a specimen of the method of doing this. I shall now proceed to do so, under the head of *Waking-up mind*. The teacher of any experience knows, that if he will excite a deep and profitable interest in his school, he must teach many things besides *book-studies*. In our common schools, there will always be a company of small children, who, not yet having learned to read understandingly, will have no means of interesting themselves, and must depend mainly upon the teacher for the interest they take in the school. This to them is, perhaps, the most critical period of their lives. Whatever impression is now made upon them will be enduring. If there they become disgusted with the dulness and confinement of school, and associate the idea of pain and repulsiveness with that of learning, who can describe the injury done to their minds? If, on the other hand, the teacher is really skilful, and excites in them a spirit of inquiry, and leads them in suitable ways to observe, to think, and to feel that the school is a happy place even for children, it is one great point gained.

I may suggest here, then, that it would be well to set apart a few minutes once a day for a *general exercise* in the school, when it should be required of all to lay by their studies, assume an erect attitude, and give their undivided attention to whatever the teacher may bring before them. Such a course would have its physiological advantages. It would relieve the minds of all for a few minutes. The erect attitude is a healthful one. It would also serve as a short respite from duty, and thus refresh the older scholars for study. I may further add, that, for the benefit of these small children, every general exercise should be conducted with reference to *them*, and such topics should be introduced as they can understand.

EXTENT OF THE SEA.—The surface of the sea is estimated at 150 millions of square miles, taking the whole surface of the globe at 197 millions; and its greatest depth is supposed to be equal to that of the highest mountains, or four miles; but La Place thinks that the tides demand an average depth of three miles; therefore, the sea contains 450 millions of cubic miles of the 258,000 millions in the whole globe.

NATURAL PHILOSOPHY.

CHAPTER XXI.

OF MOTION ROUND A CENTRE.—Continued from page 188.

Peculiarity of Motion on a Curve.—Centrifugal Force.—Conditions of Free Curvilinear Motion.—Motion of the Planets.—Motion in a Circle.—Motion in an Ellipse.—Rotation on an Axis.—Figure of Revolution.—Stability of the Axis of Rotation.

IN considering the motion of bodies down inclined planes, we have shown that the action of gravity upon them may be divided into two portions—one producing pressure upon the plane, and therefore acting perpendicularly to its surface; the other acting parallel to the plane, and therefore producing motion down it.

It has also been shown that, in some respects, there is an analogy between movements over inclined planes and over curved lines, but a further consideration proves that between the two there is also a very important difference. A pressure occurs in the case of a body moving on a curve which is not found in the case of one moving on a plane. It arises from the inertia of a moving body. Thus, if a body commences to move down an inclined plane, the force producing the motion is, as we have seen, parallel to the plane. From the first moment of motion to the last, the direction is the same, and inasmuch as the inertia of the body, when in motion, tends to continue that motion in the same straight line, no deflecting agency is encountered.

But it is very different with motion on a curve. Here the direction of descent from A to B is perpetually changing; the curve from its form resists, and therefore deflects the falling body. At any point its inertia tends to continue its motion in a straight line: thus, at A, were it not for the curve it would move in the line, A a, at B in the line, B b, these lines being tangents to the curve at the points A and B. The curve, therefore, continually deflecting the falling body, experiences a pressure itself—a pressure which obviously does not occur in the case of an inclined plane. This pressure is denominated “centrifugal force,” because the moving body tends to fly from the centre of the curve.

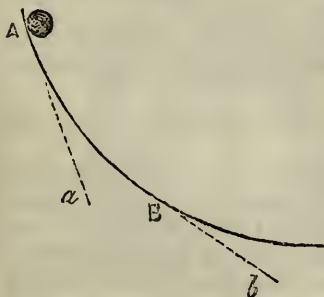


Fig. 107.

In the foregoing explanation we have regarded the body as being compelled to move in a curvilinear path, by means of an inflexible and resisting surface. But it may easily be shown that the same kind of motion will ensue without any such compelling or resisting surface, provided the body be under the control of two forces, one of which continually tends to draw it to the centre of the curve in which it moves, while the other, as a momentary impulse, tends to carry it in a different direction.

Thus, let there be a body A, Fig. 108, attracted by another body, S, and also subjected to a projectile force tending to carry it in the direction A H. Under the conjoint influence of the two forces it will describe a curvilinear orbit, A T W.

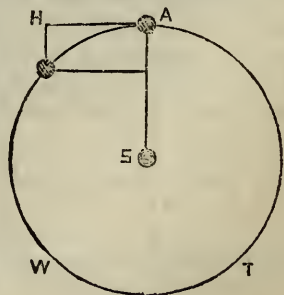


Fig. 108.

The point to which the first force solicits the body to move is termed the centre of

gravity—that force itself is designated the centripetal force, and the momentary force passes under the name of tangential force.

The following experiment clearly shows how, under the action of such forces, curvilinear motion arises. Let there be placed upon a table a ball, A, and from the top of the room, by a long thread, let there be suspended a second ball, B, the point of suspension being vertically over A. If now we remove B a short distance from A, and let it go, it falls at once on A, as though it were attracted. It may be regarded, therefore, as under the influence of a centripetal force emanating from A. But if, instead of simply letting B drop upon A, we give it an impulse in a direction at right angles to the line in which it would have fallen, it at once pursues a curvilinear path, and may be made to describe a circle or an ellipse according to the relative intensity of the tangential force given it.

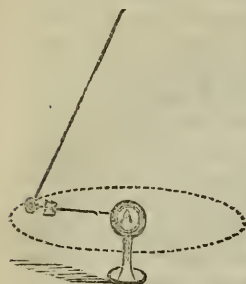


Fig. 109.

This revolving ball imitates the motion of the planetary bodies round the sun.

To understand how these curvilinear motions arise, let C be the centre of gravity, and suppose a body at the point, *a*. Let a tangential force act on it in such a manner as to drive it from *a* to *b*, in the same time as it would have fallen from *a* to *d*. By the parallelogram of forces it will move to *f*. When at this point, *f*, its inertia would tend to carry it in the direction *fg*, a distance equal to *af*, in a time equal to that occupied in passing from *a* to *f*; but the constant attractive force still operating tends to bring it to *h*; by the parallelogram of forces it therefore is carried to *h*; and by similar reasoning we might show that it will next be found at *n*, and so on. But when we consider that the centripetal force acts continually, and not by small interrupted impulses, it is obvious that, instead of a crooked line, the path which the body pursues will be a continuous curve.

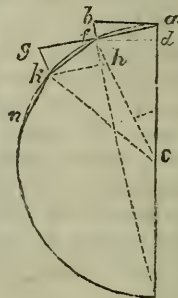


Fig. 110.

The planets move in their orbits round the sun, and the satellites round their planets, in consequence of the action of two forces—a centripetal force, which is gravitation, and a tangential force originally impressed on them.

The centrifugal force obviously arises from the action of the tangential. It is the antagonist of the centripetal force.

The figure of the curve in which a body revolves is determined by the relative intensities of the centripetal and tangential forces. If the two be equal at all points, the curve will be a circle, and the velocity of the body will be uniform. But if the centrifugal force at different points of the body's orbit be inversely as the square of its distance from the centre of gravity, the curve will be an ellipse and the velocity of the body variable.

In elliptical motion, which is the motion of planetary bodies, the centre of gravity is in one of the *foci* of the ellipse. All lines drawn from this point to the circumference are called *radii vectores*, and the nature of the motion is necessarily such that the *radius vector* connecting the revolving body with the centre of gravity sweeps over equal areas in equal times.

The squares of the velocities are inversely as the distances, and the squares of the times of revolution are to each other as the cubes of the distances.

Let A B D E, Fig. 111, be an elliptical orbit, as, for example, that of a planet, the longest diameter being A B, and the shortest D E. The points, F and G, are the *foci* of the ellipse, and in one, as F, is placed the centre of gravity, which, in this instance, is the sun. The planet, therefore, when pursuing its orbit, is much nearer to the sun when at A than when at

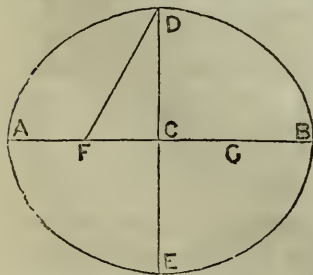


Fig. 111.

B. The former point is, therefore, called the *perihelion*, the latter the *aphelion*, and D and E points of *mean distance*. The line A B, joining the perihelion and aphelion, is the *line of the apsides*; it is also the greater or *transverse axis* of the orbit, and D E is the *conjugate* or less axis. A line drawn from the centre of gravity to the points D or E, as F D, is the *mean distance*, F is the *lower focus*, G the *higher focus*, A the *lower apsis*, B the *higher apsis*, and F C or G C—that is the distance of either of the foci from the centre—the *eccentricity*.

When a body rotates upon an axis, all its parts revolve in equal times. The velocity of each particle increases with its perpendicular distance from the axis, and therefore, so also does its centrifugal force. As long as this force is less than the cohesion of the particles, the rotating body can preserve itself, but as soon as the centrifugal force overcomes the cohesive, the parts of the rotating mass fly off in directions which are tangents to their circular motion.

There are many familiar instances which are examples of these principles; the bursting of rapidly rotating masses, the expulsion of water from a mop, the projection of a stone from a sling.

If the parts of a rotating body have freedom of motion among themselves, a change in the figure of that body may ensue by reason of the difference of centrifugal force of the different parts. Thus, in the case of the earth, the figure is not a perfect sphere, but a spheroid, the diameter or axis upon which it revolves, called its polar diameter, is less than its equatorial, it having assumed a flattened shape toward the poles and a bulging one toward the equator. At the equator, the centrifugal force of a particle is $\frac{1}{289}$ of its gravity. This diminishes as we approach the poles, where it becomes 0. The tendency to fly from the axis of motion has, therefore, given rise to the force in question.

This may be illustrated by an instrument represented in Fig. 112, which consists of a set of circular hoops, made of brass or other elastic material. They are fastened upon an axis at the point, *a*, but at the point *b* can slide up and down the axis. When at rest they are of a circular form. By a multiplying wheel a rapid rotation can be given them, and when this is done they depart from the circular shape and assume an elliptical one, the shorter axis being the axis of rotation.

But if the parts of the rotating body have not perfect freedom of motion among themselves, their centrifugal force gives rise to a pressure upon the axis. If the mass is symmetrical as respects the axis, the resulting pressures compensate each other. But as each one of the rotating particles, by reason of its inertia, has a disposition to continue its motion in the same plane, it is obvious that such a *free axis* can only

be disturbed from its position by the exercise of a force sufficient to overcome that effect. It is this result which is so well illustrated by Bohnenberger's machine, already described.

CHAPTER XXII.

OF ADHESION AND CAPILLARY ATTRACTION.

Adhesion of Solids and Liquids.—Law of Wetting.—Capillary Attraction.—Elevations and Depressions.—Relations of the Diameter of Tubes.—Motions by Capillary Attraction.—Endosmosis of Liquids and of Gases.

To the arm of a balance, *b c*, Fig. 113, let there be attached a flat circular plate of glass, *a*, and let it be equipoised by the weights in the opposite scale, *d*; beneath it let

there be brought a cup of water, *e*, and on lowering the glass plate within an inch, or even within the hundredth part of an inch of the water, no attraction is exhibited; but if the glass and the water are brought in contact, then it will require the addition of many weights in the opposite scale to pull them apart.

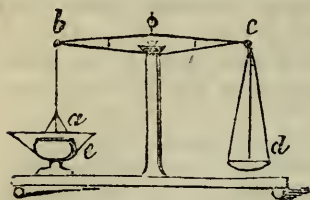


Fig. 113.

If the cup, instead of being filled with water, is filled with quicksilver, alcohol, oil, or any other liquid, or if instead of a plate of glass we use one of wood or metal, the same effects still ensue. The force which thus maintains the surface in contact is called "Adhesion."

[If we cut a piece of lead into two parts with a clean knife, and afterwards press the newly divided surfaces together giving them a twisting motion at the same time, we shall find them adhere firmly. When India-rubber is cut with a clean knife, the fresh-cut surfaces will cohere in a similar manner.—W. T. K.]

Adhesion does not alone take place between bodies of different forms. Two perfectly flat plates of glass or marble, when pressed together, can only be separated by the exertion of considerable force. In both this and the former case the absolute force required to effect a separation depends on the superficial area of the bodies in contact.

If, on bringing a given solid in contact with a liquid, the force of adhesion is equal to more than half the cohesive force of the liquid particles for one another, the liquid will adhere to the solid or *wet it*. Thus, the adhesive force developed when gold is brought in contact with quicksilver is more than half the cohesion of the particles of the quicksilver for each other: the quicksilver, therefore, adheres to or wets the gold.

But if the force of adhesion developed between a solid and liquid is less than half the cohesive force of the particles of the latter, the liquid does not wet the solid. Thus, a piece of glass in contact with quicksilver is not wetted.

It is on these principles that Vera's pump acts. It consists of a cord which passes over two wheels, to which a rapid motion can be given. The water adheres to the cord and is raised by it. See Fig. 73, Chap. XIII.

If the surface of some water be dusted over with lycopodium seeds, the fingers may be plunged in it without being wetted, the lycopodium preventing any adhesion of the water.

But it is in the phenomena of capillary attraction that we see the effects of adhesion in the most striking manner. These phenomena are exhibited by tubes of small diameter, called capillary tubes, because their bore is as fine as a hair. If such a tube, *a*, Fig. 114, be immersed in water, the water at once rises in it to a height considerably above its level, in the glass cup, *b*.

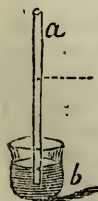


Fig. 114.

Or if instead of water we fill the glass cup with quicksilver, and immerse the tube in it, bringing it near the side so that we can see the metal in the interior of the tube through the glass, it will be found to be depressed beneath its proper level.

These experiments are still more conveniently made by means of tubes bent in the form of a syphon, as represented in Fig. 51, Chapter X. If one of these be partially filled with water, and then with quicksilver, the water will be seen to rise in the narrow tube above its level in the wide tube, and the quicksilver to be depressed.

[Perhaps the most common examples we can furnish of capillary attraction are the following, which we adduce without comment:—1. A lump of sugar placed upon a wet surface, becomes very soon saturated throughout. 2. A sponge placed in a saucer of water soon absorbs all the fluid. 3. A piece of blotting-paper applied to some ink upon a sheet of paper. 4. The action of the wicks of candles and lamps, &c. —W. T. K.]

When tubes of different diameters are used, the change in the level of the liquid is different. The narrower the tube, the higher water will rise, and the lower will quicksilver be depressed.

When tubes are very wide, or what comes to the same thing, when liquids are contained in bowls or basins, the surface is found not to be uniformly level; but near those points where it approaches the glass, in the case of water, it curves upward, and in the case of quicksilver it curves downward, as seen in Fig. 115.

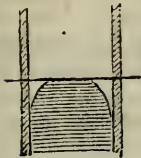


Fig. 115.

In tubes of the same material dipped in the same liquid, the elevations or depressions are inversely as the diameters of the tubes, the narrower the tube the higher will water rise, and the deeper will quicksilver be depressed.

There is a beautiful experiment which shows the connection between the diameter of the tube and the height to which it will lift a liquid.

Two square pieces of plate-glass, A B, C D, Fig. 116, are arranged so that their surfaces form a minute angle. This position may be easily given, by fastening them together with a piece of wax or cork, K. When the plates are dipped into a trough of water, E F, G H, the water rises in the space between them to a smaller extent where the plates are far apart, and to a greater where they are closer. The upper edge of the water gives the form of a hyperbola, D I A. The plates may be supposed to represent a series of capillary tubes of diameters continually decreasing; they show that the narrower the intercluded space or bore of such tubes the higher the liquid will rise.

The figure of the surface which bounds a liquid in a capillary tube is also to be remarked. Whenever a liquid rises in a tube, its bounding surface is concave upward, as seen in Fig. 117, where $f g$ is the tube, and $a a$ the surface. When the liquid

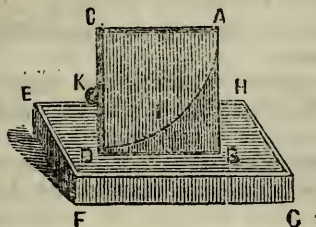


Fig. 116.

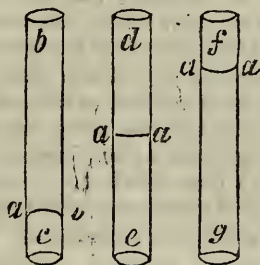


Fig. 117.

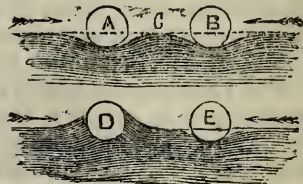


Fig. 118.

neither rises nor sinks, the surface, $a a$, is plane, as at $d e$; when the liquid is depressed, the surface, $a a$, is convex upward, as seen at $b c$. All these conditions may be exhibited by a glass tube properly prepared. In such a tube, when quite clean, the concavity and elevation of the liquid is seen; if the interior of the tube be slightly greased, the surface of the water in it is plane, and it coincides in position with the level on the exterior. If it be not only greased, but also dusted with lycopodium, the liquid is depressed in it, and has a convex figure.

It may be shown, according to the principles of hydrostatics, that it is the assumption of this curved surface which is the cause of the elevation or depression of liquids in capillary tubes.

Motions often ensue among floating bodies in consequence of capillary attraction. At first sight they might seem to indicate the exertion of direct forces of attraction and repulsion emanating from the bodies themselves; but this in reality is not the case, the motions arising in consequence of a disturbance of the figure of the surface on which the bodies float. Thus, if we grease two cork balls, A B, and dust them with lycopodium powder, they will, when set upon water, repel the liquid all round, each ball reposing in a hollow space. If brought near to each other, their repulsion exerted on the water at C makes a complete depression, and they fall toward one another as though they were attracting each other. It is, however, the lateral pressure of the water beyond which forces them together.

Again; if one of the balls, E, is greased and dusted with lycopodium, and the

other, D, clean, and therefore capable of being moistened, an elevation will exist all round D, and a depression round E. When placed near together, the balls appear to repel each other, the action in this case, as in the former, arising from the figure of the surface of the water.

If we take a small bladder, or any other membranous cavity, and having fastened it on a tube open at both ends, A B, Fig. 119, fill the bladder and tube to the height, C, with alcohol, and then immerse the bladder in a large vessel of water; it will soon be seen that the level at C is rising, and at a short time it reaches the top of the tube at B, and overflows. This motion is evidently due to the circumstance that the water precolates through the bladder, and the phenomenon has sometimes been called endosmosis, or inward movement. Examination proves that while the water is thus flowing to the interior, a little of the alcohol is moving in the opposite way; but as the water moves quicker than the alcohol, there is an accumulation in the interior of the bladder, and, consequently, a rise at C.

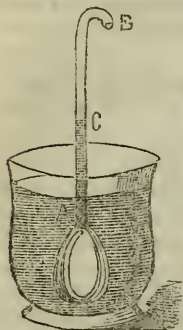


Fig. 119.

One liquid will thus intrude itself into another with very great force. A bladder filled full of alcohol, and its neck thickly tied, will soon burst open if it be plunged beneath water.

Similar phenomena are exhibited by gases. If a jar be filled with carbonic acid gas, and a piece of thin India-rubber tied over it, the carbonic acid escapes into the air through the India-rubber, which becomes deeply depressed, as at A, Fig. 120. But if the jar be filled with air, and be exposed to an atmosphere of carbonic acid, this gas, passing rapidly through it, accumulates in the interior of the vessel, and gives to the India-rubber a convex or dome-shaped form, as seen at B.

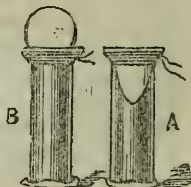


Fig. 120.

Endosmosis is nothing but a complex case of common capillary attraction.

The facts here described were originally discovered by Priestley; but at a later period attention was called to them by Dutrochet, who, regarding them as being due to a peculiar physical principle, gave to the movements in question the names of endosmose and exosmose, meaning inward and outward motion. But I have shown that there is no reason to revert to any peculiar physical principle, since the laws of ordinary capillary attraction explain every one of the facts.

The bursting of a bladder filled with alcohol and sunk under water gives us some idea of the power with which the latter liquid forces its way into the membranous cavity; and it is surprising with what a degree of energy these movements are often accomplished. An opposing pressure of two or three atmospheres seems to offer no obstacle whatever, and I have seen gases pass through India-rubber to mingle with each other, though resisted by pressures of from twenty to fifty atmospheres.

Whenever liquids which can commingle are placed on opposite sides of a membrane or cellular body which they can wet, motion ensues; both liquids simultaneously moving in opposite directions, and commonly one much faster than the other. Thus, if a bladder full of gum-water is immersed in common water, the latter will find its way into the former against any pressure whatever.

During the growth of trees, the terminations of their roots, which are of a soft and succulent nature, and which pass under the name of *spongioles*, are filled with a gummy material which originally was formed in the leaves. The moist or wet soil with which the *spongioles* are in contact, continually furnishes a supply of water which enters those organs in precisely the same way that it would enter a bladder full of gum-water. An accumulation takes place in the organs, and the liquid rises in the vascular parts of the root and the stem, which are in connection therewith. To this we give the name of *ascending sap*. It makes its way to the leaves, there to be changed into gum-water by the action of the light of the sun. It is immaterial how high a tree may be; the force now under consideration is competent to lift the sap to any altitude.

SECTION IV.—PROPERTIES OF SOLIDS.

CHAPTER XXIII.

GENERAL PROPERTIES OF SOLIDS.

Distinctive Properties.—Changes by particular Processes.—Absolute Strength.—Lateral Strength.—Resistance to Compression.—Torsion.—Torsion Balance.

A substance which can of itself maintain an independent figure has already been defined as a solid body. This peculiarity arises from the relative intensity of the attractive and repulsive forces which obtain among its particles. In solids the attractive predominates over the repulsive force; in liquids there seems to be little difference in their intensity; in gases the repulsive force prevails. It is further to be observed, that portions of gas uniformly mix with each other; the same also takes place with liquids of a similar kind; but when a fragment is broken from a solid mass mere coaptation will not effect reunion.

The cohesive force of solids is exhibited in very different degrees—some solids being brittle, and some ductile—some are hard, and others soft. Thus glass and bismuth may be pulverized in a mortar; but gold can be beaten out to an incredible extent by a hammer, and copper drawn into fine wires. The diamond is the hardest of all substances known, and, from their possessing the same quality, rhodium and iridium are used for the tips of metallic pens, while other solids, such as potassium, sodium, butter, are soft, and yield to a very moderate pressure.

It has already been stated that the special properties which bodies possess can often be changed by proper processes. Thus glass, by slow cooling, loses much of its brittleness; and steel may be made excessively hard by being ignited and then plunged in cold water. Prince Rupert's drops furnish an illustration of these effects; they are made by suffering drops of melted glass to fall in water. The drop takes on a pear-shaped form, terminating in a long thread. It will stand a tolerably heavy blow on the thick part, but bursts to dust if the tip of the thin part is broken.

Solid substances differ very much in the important peculiarity of **STRENGTH**. Of all bodies steel is the strongest. The strength of materials may be considered in four ways:

1st. Absolute strength, or the resistance exerted against a force tending to tear asunder.

2nd. Lateral or respective strength—the resistance exerted against being broken across.

3rd. Resistance to compression—that is to a force tending to crush.

4th. Strength of torsion—the resistance against separation by being twisted.

The absolute strength of a body may be determined by fastening its upper end and attaching weights to the lower till it breaks. The absolute strength is not affected by the length of a body, but is proportional to the area of its section. A rod of tempered steel, the area of which is one inch, requires nearly 115,000lbs. to tear it asunder. The strength of cords depends on the fineness of the strands; damp cordage is stronger, than dry. Silk cords, of the same diameter, have thrice the strength of those of flax, and a remarkable increase of power arises from gluing the threads together. A hempen cord, the threads of which are glued, is stronger than the best wrought iron.

The lateral strength of a beam of the shape of a parallelopipedon and of uniform thickness, supported at its ends and loaded in the middle, is inversely as the length and directly as the product of the breadth into square of the depth, as in Fig. 121. This strength is least when the whole weight acts in the middle, and is greatest when at the ends.



Fig. 121.

The resistance to compression increases as the section of the body increases, and it diminishes as the body becomes longer. When the body is only a thin plate, its resistance to compression is, however, very small; but it rapidly increases with increasing thickness—reaches a maximum, and then diminishes as the square of the length. This species of resistance is called into operation in the construction of pillars or columns.

[The resistance of bodies to forces tending to crush them, is given by Mr. Hodgkinson ("Philos. Trans." 1840), in the following Table:

Description of Wood.	Strength per Sq. In. in lbs.	Description of Wood.	Strength per Sq. In. in lbs.
Alder	6,831 to 6,960	Mahogany	8,198 to —
Ash	8,683 „ 9,363	Oak (Quebec)	4,231 „ 5,982
Bay	7,518 „ —	„ (English)	6,484 „ 10,058
Beech	7,733 „ 9,363	Pine (pitch)	6,790 „ —
English Birch	3,297 „ 6,402	„ (red)	5,395 „ 7,518
Cedar	5,674 „ 5,863	Poplar	3,107 „ 5,724
Red Deal	5,748 „ 6,586	Plum (dry)	8,241 „ 10,493
White Deal	6,781 „ 7,293	Teak	— „ 12,101
Elder	7,451 „ 9,973	Walnut	6,063 „ 7,227
Elm	— „ 10,331	Willow	2,898 „ 6,128
Fir (spruce)	6,499 „ 6,819		

All the experiments were made upon short pillars of wood, and the force applied in the direction of the fibres. The results of the first column are deduced from experiments made upon cylinders one inch in diameter, moderately dry, and two inches long. The second column is formed from experiments made upon cylinders of the same size, kept in a warm place for two months; thus proving that wet timber is weaker than dry.]

Torsion resistance is connected with the elasticity of a body. As respects this force, elasticity, we have already defined it, and shown that no solid substance is perfectly elastic, though gases are. Each solid has its own limit of elasticity, beyond which, if it be strained, it takes a permanent set or it breaks. Mr. Tredgold found that a weight of 93,000 lbs. upon a square inch of cast-iron crushed it, but that the same material will sustain a weight of 15,300 lbs. without any alteration. The limit of elasticity of glass is the point at which it breaks, and that of iron or copper being reached, the metal takes a permanent set.

THE TORSION BALANCE consists of a delicate thread of glass, or other highly elastic substance, *a, b*, Fig. 122, fastened at its upper end, *a*, to a button, which turns stiffly in the graduated plate, *c*: and to its lower end at *b*, a lever, *b, d*, is affixed transversely. The thread is enclosed in a glass tube, *B*, and the transverse lever moves in a glass cylinder, *A*. It is thus protected from the disturbance of currents of air. Round this cylinder, from 0 to 180, graduated divisions are marked, and the whole instrument can be levelled by means of screws, *f, f*.

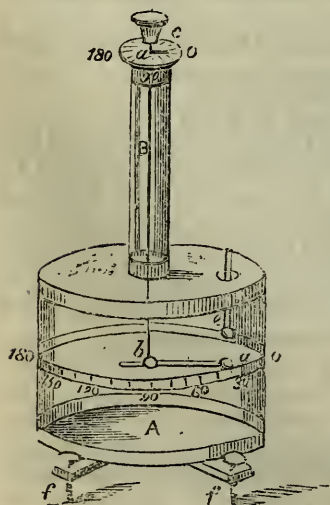


Fig. 122.

Suppose, now, it were required to measure any feeble repulsive force, as the repulsion of a little electrified ball, *e*. If this ball be introduced into the interior of the cylinder through an aperture in the top, as shown in Fig. 122, the index at *c* and the ball at *d* being both at the zero of their respective scales, the repulsion of *e* will drive the movable ball, *d*, through a certain number of degrees. By twisting the button at *a*, we can compel *d* to go back to its original position; and the number of degrees through which the thread must be twisted to effect this measures the repulsive force; for the angle of torsion is always proportional to

the force exerted. Of all the methods for determining feeble forces in a horizontal plane, the torsion balance is the most delicate and accurate.

CHEMISTRY.

(Continued from page 194.)

THE passage of a current within the cells of a voltaic battery depends also upon the decomposition in each cell, equally with that between the platinum electrodes. The same phenomena which we notice in the decomposing cell takes place also in each battery cell. Water is decomposed, and the hydrogen is given off from the positive plate, while the oxygen combines with the zinc, and thus escapes detection. Therefore, no fluid not an electrolyte is suitable to excite a battery. Acid water acts, for this purpose, only by the decomposition of the water, and oxidation of the zinc. The presence of the acid is useful only so far as it combines with the oxide of zinc constantly accumulating on the zinc plate, which must be removed as fast as formed, in order to keep up a steady flow of electricity.

From what has been said, we can see that a decomposing cell interposed in the circuit will give us an exact account of the amount of electricity flowing. Such an instrument has been called by Faraday, a *voltameter* (measurer of voltaic electricity), and is shown in Fig. 46. It differs

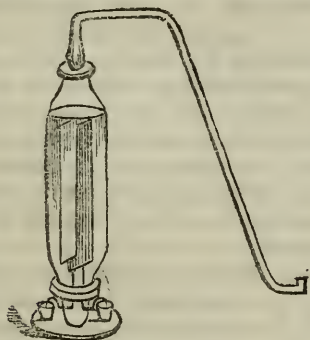


Fig. 46.

from the decomposing cell, in being a single cell, and having a ground glass tube at top bent twice, so as to deliver the accumulating gases into a graduated air-vessel, in which their volume is measured. A more simple form of the apparatus is easily constructed, as shown in Fig. 47, which is a short piece of glass tube, with two corks and a bent tube (a.) The electrodes *p, p*, pass through the corks, and should terminate in broad

plates of platinum foil. A common form of the instrument is seen in Fig. 48, which has only one tube, and that is graduated.

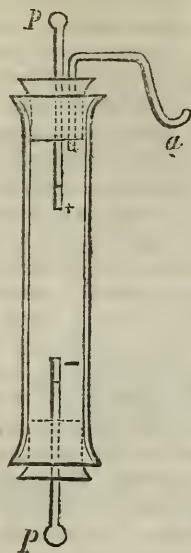


Fig. 47.

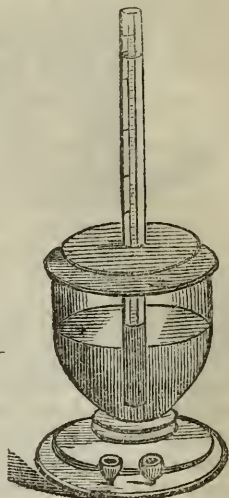


Fig. 48.

When this is filled with the mixed gases, and a lighted match is applied to the open end, the two elements unite again, with a loud explosion and vivid flash. If the apparatus is so arranged that this can be done over water without access of air, the fluid rushes up to fill the vacuum occasioned by the reunion of the elements in the formation of water.

The theories which have been proposed to account for electro-chemical decomposition and the action of the voltaic circuit, we cannot discuss here, any further than to say that the *chemical theory* first proposed by Dr. Wollaston is now generally accepted. Volta argued that the contact of different metals was essential to the production of a current. The researches of Faraday, however, in confirming the chemical view of Wollaston, have completely disproved the contact theory. A very simple experiment, by Faraday, illustrates this statement. A slip of amalgamated sheet zinc, bent at a right angle, is hung in a glass of dilute acid; on it is laid a folded piece of bibulous paper, moistened with iodide of potassium. A platinum plate, with an attached wire of the same metal, is now placed in the acid water, but not in contact with the zinc;

the sharpened end of the wire is bent, so as to touch the moistened paper, and very soon it is discoloured by a brown spot made by the free iodine, liberated from the electro-chemical decomposition of the iodide of potassium, with which the paper is moistened. There is no contact of metals,

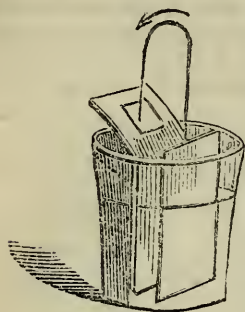


Fig. 49.

and the current is excited only from the decomposition of the iodide out of the cell, and of the water in it. A very strong argument in favour of the chemical theory has been before mentioned, that the direction of the current is always determined by the *nature of the chemical action*—the metals most acted on being always positive. Professor Berzelius, in view of the facts of electricity, considers all chemical action as the result of opposite electrical states in the elements and their compounds.

We have now made all the explanations that are necessary to enable us to understand the principle and construction of—

Sustaining Batteries.—Local Action.—In the old forms of batteries made of copper and zinc unamalgamated, there is always a great amount of local action in each cell, arising from the impurity of the zinc. In order to have a constant voltaic current of equal power, not only the evils arising from local action must be avoided, but also, in some degree, the weakening of the acid solution. Batteries so constructed as to meet these difficulties, are called *sustaining batteries*, or constant batteries. We will first mention

Daniell's Constant Battery.—This truly philosophical instrument, the value of which is very apparent, is made up of an exterior cell of copper three and a half inches in diameter, which serves both as a containing vessel and as a negative element; a porous, cylindrical cup of earthenware (or, as it may be, the membrane of an ox-gullet), is placed within the copper cell, and a solid cylinder of amalgamated zinc within the porous cup.

The outer cell is then charged by a mixture of eight parts of water and one of oil of vitriol, saturated with blue vitriol, (sulphate of copper.) Some of the solid sulphate is also suspended on a perforated shelf, or in a gannez bag, to keep up the saturation. The inner cell is filled with the same acid water, but without the copper salt. Any number of cells so arranged

are easily connected together by binding screws, as in the figure. This instrument, when arranged and charged as here described, will give out no gas. The hydrogen from the decomposed water is not given off in bubbles on the copper side, as in all forms of the simple circuit of zinc and copper; because the sulphate of copper there present is decomposed by the circuit, atom for atom, with the decomposed water, and the hydrogen takes the atom of oxide of copper,

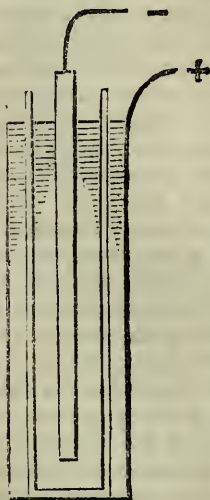


Fig. 50.

appropriating its oxygen to form water again, and metallic copper is deposited on the outer cell. No action of any sort results in this battery, when properly arranged, until the poles are joined. Ten or twelve such cells form the most active, constant, and least costly battery which can be procured.

Grove's Battery.—Professor Grove, of London, has contrived another compound sustaining battery, of great power, and most remarkable intensity of action. The metals used are platinum and amalgamated zinc. A vertical section of this battery is shown in Fig. 51. The platinum (+) is placed in a porous cell of earthenware, containing strong nitric acid. This is surrounded by the amalgamated zinc (—) in an outer vessel of dilute sul-



Fig. 51.

phuric acid (six to ten parts water to one of acid, by measure.) The platinum, being the most costly metal, is here surrounded by the zinc, in order to economize its surface as much as possible. In this battery the hydrogen of the decomposed water on the zinc side enters the nitric acid cell, decomposes an equivalent of the acid, forming water with one equivalent of its oxygen, while the deutoxide of nitrogen is given out as a gas, and coming in contact with the air is converted into nitrous acid fumes. No other form of battery can be compared with this for intensity of action. A series of four cells (the platinum foil being only three inches long and half an inch wide) will decompose water with great rapidity; and twenty such cells will evolve a very splendid arch of light from points of prepared charcoal, and deflagrate all the metals very powerfully. It is rather costly, and troublesome to manage, as are all batteries with double cells and porous cups. The author has contrived a very efficient form of the same battery, in which mineral carbon (plumbago), is substituted for the platinum; and the carbon battery of Bunsen is constructed on the same principles, and produces most brilliant effects. But all other batteries yield in simplicity and ease of management to that contrived by Mr. Smee.

Smee's Battery is formed of zinc and silver, and needs but one cell and one fluid to excite it. The silver plate is prepared by coating its surface with platinum, thrown down on it by a voltaic current, in the state of fine division, which is known as platinum-black. The object of this is to prevent the adhesion of the liberated hydrogen to the polished silver. Any polished smooth surface of metal will hold bubbles of gas with great obstinacy, thus preventing in a measure the contact between the fluid and the plate by the interposition of a film of air-bubbles. The roughened surface produced from the deposit of platinum-black entirely prevents this. The zinc plates in this battery are well amalgamated, and face both sides of the silver. The three plates are held in position by a clamp at top, and the interposition of a bar of dry wood, prevents the passage of a current from plate to plate. Water, acidulated with one-seventh its bulk of oil of vitriol, or, for less activity,

with one-sixteenth, is the exciting fluid. The quantity of electricity excited in this battery is very great, but the intensity is not as great as in those compound batteries just described, where there is a double electrolysis, and, of course, a double intensity acquired. This battery is perfectly constant, does not act until the poles are joined, and, without any attention, will maintain a uniform flow of power for days together. A plate of lead, well silvered, and then coated with platinum-black, will answer equally as well, and indeed better than a thin plate of pure silver. This battery is recommended over every



Fig. 52.

other for the student, as comprising the great requisites of cheapness, ease of management, and constancy. A form of it, well calculated for the student's laboratory, is here shown, which is a porcelain trough with many cells. This battery is the one universally employed in electro-metallurgy.

Electro-metallurgy.—The depositing of metals by electrical agency seems to have been suggested by Daniell's battery. It has been remarked, that the copper of the sulphate of copper in the outer cell of that battery is deposited in a metallic state. The procuring of a pure metal in a perfectly malleable state, by means of a current of electricity, is a most important fact, and has given rise to a new and valuable art, which is every day extending its applications.

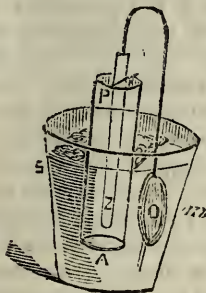


Fig. 53.

lurgic processes. The very simple apparatus

able art, which is every day extending its applications. We thus accomplish, in fact, a cold casting of copper, silver, gold, zinc, and many other metals; and a new field of great extent has been thus opened for the application of metal-

required to show these results experimentally, is represented in Fig. 53. It is nothing, in fact, but a single cell of Daniell's battery. A glass tumbler (S), a common lamp-chimney (P), with a bladder-skin tied over the lower end and filled with dilute acid, is all the apparatus required. A strong solution of sulphate of copper is put in the tumbler (S), and a zinc rod (Z) in P; the mould, or cast (*m*), seen suspended by a wire attached to the binding screw of Z. Thus arranged, the copper solution is slowly decomposed, and the metal is evenly and firmly deposited on *m*. A perfect reverse copy of *m* is thus obtained in solid malleable copper. The back of *m* is protected by varnish, to prevent the adhesion of the metallic copper to it. In this manner the most elaborate and costly medals are easily multiplied, and in the most accurate manner. In practice, casts are made in fusible metal of the object to be copied, and the operation is conducted in a separate cell, containing not only the sulphate of copper, one of Smee's batteries supplying the power. The art is also now extensively applied to plating in gold and silver from their solutions; the metals thus deposited adhering perfectly to the metallic surface on which they are deposited, provided these be quite clean and bright. Many details in these processes, very needful to the successful practice of the art, are necessarily omitted here.

We have now finished our preliminary view of those great powers of Nature, whose operations we see to a greater or less extent in every chemical process. It may be thought that we have devoted too large a space to the topics already discussed; but the author is convinced, from long observation, that if the *principles of chemical philosophy* are well acquired by the student, but little difficulty will be experienced in afterwards pursuing, even alone, and without the aid of a teacher, the wide detail of elementary chemistry. In entering on the execution of the remaining portion of our task, it is with the full understanding that no attempt is made on our part at presenting even a complete outline of the countless facts of elementary chemistry. Only such selections will be made from them as are deemed most in point to illustrate and enforce the prin-

ciples already laid down, and to increase our familiarity with the philosophy of chemistry. It is hoped that this course will be satisfactory to both teacher and pupil, and the apology implied in this remark is intended to explain any apparent deficiencies which may be seen on the succeeding pages.

LESSONS IN FRENCH.

(Continued from page 199.)

THE ARTICLE.

Of Cases in which the Sense of a Sentence Changes Entirely, by Using or Suppressing the Article before a Noun used as the Complement of a Verb.—The sense of some sentences changes sometimes entirely, on account of the use or suppression of the article, thus:

Entendre *la raillerie*, signifies to know how to rally, to jeer.

Entendre *raillerie*, signifies to know how to take a joke.

Demander *la raison* d'une chose, means to ask for the cause of a thing.

Demander *raison* d'une chose is to demand satisfaction for an offence.

Un homme *de génie*, is a man of genius.

Un homme *du génie*, is a man who belongs to the corps of engineers.

A few examples in which the Article is not used,

I will change these stones into loaves. Je changerai ces pierres en pains.

The education of Rousseau must not be taken as a model. L'éducation de Rousseau ne doit pas être prise pour modèle.

I will go to Rome. J'irai à Rome.

He received me with open arms. Il me reçut à bras ouverts.

He has arrived in safety at midnight. Il est arrivé à bon port à minuit.

To live without bread, on a pound of bread, on a little bread. Vivre sans pain, avec une livre de pain, d'un peu de pain.

In all these sentences the nouns are taken in reference to their signification alone, and therefore have no article before them, as well as in the following: I have a knave of a brother, J'ai un coquin de frère,—an elliptical sentence, which means, Which is of the species of a brother, *Qui est de l'espèce de frère*; An honest father, Un honnête homme de père. Elliptical sense, meaning,—An honest man, having

the quality of a father, *Un honnête homme ayant la qualité de père.*

These constructions, as well as all similar ones, are in conformity with the rules already laid down, by the means of the ellipsis.

The following expressions. To act by feeling, *Agir par sentiment*; To speak with wit, *Parler avec esprit*; To make a graceful appearance, *Représenter avec grâce*; To act with passion, *Agir par colère*; To act by spite, *Agir par dépit*; To act by love, *Agir par amour*, are adverbial; and the nouns, being used adjectively with the prepositions, are indefinite; therefore, they admit of no article.

OF THE SUBSTANTIVE.

Of the Nature of the Substantive.—The substantive is a word which represents a being, or an object, or an idea, or a feeling, whatever it may be, existing in reality, or only by the power of our mind.

The substantive is also called *Noun*, because it is used to name the persons, things, ideas, or feelings which they represent; man, *homme*; horse, *cheval*; fish, *poisson*, are nouns representing beings which have the appearance of man, horse, and fish. Hope, *espérance*; perfection, *perfection*; happiness, *bonheur*, are nouns representing ideas and feelings through the operation of our minds. Tree, *arbre*; table, *table*; book, *livre*, are nouns representing objects so designated by the general agreement of society.

There are two sorts of substantives. Those which are used to designate the whole of the species which they represent; as, *homme, cheval, espérance, arbre*, are called *Common Nouns*, because they are common to all beings or things of the same kind.

Those which are used only to designate a single individual or thing: as, *Alexandre, Virgile, Paris, Vienne*. They are called *Proper Nouns*, because they belong to a single individual of the species which they represent, at least in the mind of the person who speaks.

The substantive has two properties, *Number and Gender*.

Of Number in the Substantive.—Number is the property which the noun has to represent a *unity* or a *plurality*.

Therefore, there are two numbers; the

Singular, which represents but a single individual or thing, &c.: as, a man, *un homme*; a tree, *un arbre*; a hope, *une espérance*; and the *Plural*, which represents more than one individual or thing, &c.; as, men, *les hommes*; two trees, *deux arbres*; hopes, *les espérances*. Among nouns, the generality may be used in either number; but there are some few which have no plural, and others which have no singular. We will speak of them hereafter.

Of Gender in the Substantive.—Gender is the property which a noun has to represent a distinction between the two sexes.

There are, consequently, two genders; the *Masculine*, which belongs to man and the males among animals, and the *Feminine*, which belongs to females in general; as, man, *homme*; lion, *lion*; are masculine, because they represent males.

Woman, *femme*; mare, *jument*; are feminine, because they represent females.

By imitation, the nouns which represent objects or ideas which are neither male or female, have received one or the other of these two qualifications, and some of them are sometimes masculine and sometimes feminine, according to their signification. The distinction of the genders in those nouns is one of the greatest difficulties of the French language for foreigners. We have already, at the beginning of this Grammar, given a complete system for the classification of nouns; but in most cases the exceptions are so numerous, that it is always prudent not to trust memory alone, and to consult a good dictionary.

We see, then, that the nouns which are *neuter* in English have not the same qualification in French, which is deprived of such a gender.

To mark the difference in sexes, males and females are sometimes called by different names; as,

Masculine.		Feminine.	
Homme,	man.	Femme,	woman.
Cheval,	horse.	Jument,	mare.
Taureau,	bull.	Vache,	cow.

Sometimes, the only distinction between them is in their termination; as,

Masculine.		Feminine.	
Lion,	lion	Lionne,	lioness.
Chien,	dog.	Chienne,	bitch.
Chat,	cat.	Chatte,	cat.

This is the best designation, because it shows at once what we intend to speak of.

But often we use the same word to express the male and female; as, Partridge, *perdrix*; Eagle, *aigle*; Carp, *carpe*; Pike, *brochet*.

This mode is quite an imperfection in the language; but by consulting the article on *genders*, this difficulty is easily remedied.

As to nouns, which should be neuter in English, their gender is usually arbitrary; so

Book,	<i>livre</i> ,	Table,	<i>table</i> ,
Hat,	<i>chapeau</i> ,	Song,	<i>chanson</i>
Glass,	<i>verre</i> ,	Lamp,	<i>lampe</i> ,
Courage,	<i>courage</i> ,	Anger,	<i>colère</i> ,
are masculine,		are feminine,	

although they have no connection with either sex.

Formation of the Feminine in Nouns.—As there are a great quantity of words employed as nouns, which are used in either gender, it is necessary to show how they differ, when they represent a masculine or feminine idea, thing, or being. Masculine nouns ending with a consonant or with the vowels *é, i, u*, form their feminine termination by the addition of a mute *e*; as, *Le serin, la serine*; a canary bird; *Le bienvenu, la bienvenue*; welcome; *Un idiot, une idiote*; an idiot; *Un jardinier, une jardinière*; a male or female gardener.

The following nouns are an exception to this rule:—*Bachelier*, a bachelor; *Duc*, a duke; *Mortel*, a mortal; *Quaker*, a quaker; *Roi*, a king, &c.; *Paysan*, a peasant; *Juif*, a Jew; *Bailli*, a bailiff; *Abbé*, an abbot; *Sot*, a fool; *Veuf*, a widower; *Malin*, a shrewd fellow; *Favori*, a favourite. Which makes in the feminine:—*Bachellete*, *duchesse*, *mortelle*, *Quakeresse*, *reine*, *paysanne*, *Juive*, *bailive*, *abbesse*, *sotte*, *veuve*, *maligne*, *favorite*, &c.

Formation of the Feminine in Nouns ending with a mute e.—Masculine nouns ending with a mute *e* do not change their termination in the feminine; as *Un esclave, une esclave*; a male or female slave. *Un impie, une impie*; an impious man or woman; *Un sauvage, une sauvage*; a male or female savage, &c.

Some few nouns, however, although ending with a mute *e*, form their feminine

termination by changing *e*, into *esse*; as, *Ane, anesse*; an ass; *Tigre, tigresse*; a tiger; *Chanoine, chanoinesse*; a canon, a canoness; *Prince, princesse*; a prince, a princess; *Nègre, nègresse*; a negro, a negress; *Prêtre, prêtresse*; a priest, a priestess; *Traître, traîtresse*; a traitor, a traitress; *Ivrogne, ivrognesse*; a drunkard, a drunken woman; *Pauvre, pauvrese*; a pauper, a beggar-woman, &c.

Formation of the Feminine in Nouns ending in en, on, et.—Nouns ending in *en, on, and et*, in their masculine signification, from their feminine in doubling their last consonant and adding a mute *e*; as *Un Chrétien, une Chrétienne*; a Christian; *Un Indien, une Indienne*; an Indian; *Un fripon, une friponne*; a cheat; *Un coquet, une coquette*; a beau, a coquette, &c. Exceptions: *Compagnon*, a companion; *Patron*, a patron; *Indiscret*, a telltale, make in the feminine, *Compagne*, *patron* and *patronesse*, *indiscrète*.

Formation of the Feminine in Nouns ending in eur.—Masculine nouns ending in *eur*, and derived from present participles, form their feminine termination by changing *eur* into *euse*; as,

Chanteur, chanteuse, a singer (from *chantant*, present participle of *chanter*, to sing).

Boudeur, boudeuse, one that pouts (from *boudant*, present participle of *bouder*, to pout).

Connaisseur, connaisseuse, a connoisseur (from *connaissant*, present participle of the verb *connaître*, to know, &c.).

Many other nouns ending in *eur* in the masculine, form their feminine termination by changing *eur* into *rice*; as,

Un bienfaiteur, une bienfaitrice, a benefactor, a benefactress.

Un protecteur, une protectrice, a patroness.

Un calomniateur, une calomniatrice, a slanderer.

Un ambassadeur, une ambassadrice, an ambassador, an ambadress, &c.

Finally, a few nouns change *eur* into *eresse* for the feminine; as,

Bailleur, baillesse, the lessor.

Chasseur, chassesse, hunter, huntress.

Devin, devineresse, a diviner, divineress.

Enchanteur, enchantresse, enchanter, enchantress.

Pêcheur, pécheresse, a sinner, male and female.

Vengeur, vengeresse, an avenger.

Formation of the Feminine in Nouns ending in x.—Masculine nouns ending in

x, form their feminine termination by changing *x* into *se* ; as,

Epoux, épouse, husband, wife.

Un paresseux, une paresseuse, a lazy man or woman.

Un malheureux, une malheureuse, a wretched man or woman.

Of Nouns which are either Masculine or Feminine, according to their Number and Signification.—Nouns have generally but one gender; however, there are some which are sometimes masculine, sometimes feminine: this is the result of habit, men having applied to those nouns, sometimes a masculine, sometimes a feminine idea. We will examine successively those which are the most generally used in either gender.

Aigle, an eagle.—*Aigle*, eagle, is masculine when it designates the male of the bird of prey of that name, and when, being used metaphorically, it signifies, *a man of genius*; there is also a kind of paper called *grand aigle*, that is to say, of the largest size.

Aigle is feminine, if it designates the female of the bird of prey, and also when it signifies a military standard, or when used in speaking of coats of arms, constellations, and emblems; and also when it designates a kind of fish called *l'aigle marine*.

Amour, love, Cupid.—*Amour*, love, in the singular, is always masculine, either in prose or in poetry; it is also masculine in the plural when it signifies, (1.) All kinds of love. (2.) When it designates little Cupids which are used as emblems in the arts.

Amour, in the plural, is feminine when it implies the idea of a passion; as, Foolish inclinations, *folles amours*. First love, *les premières amours*.

Automne, autumn.—*Automne*, autumn, was formerly of either gender; it is now always masculine, as well as the names of the other seasons.

Couple, couple.—*Couple* is masculine when it designates two animated beings united by an act of their will, a feeling, or any cause making them act in concert; as,

A happy couple (speaking of man and wife), *un heureux couple*.

A couple of pigeons, *un couple de pigeons* (a male and a female).

Un couple de chevaux, a team of two horses, &c.

Couple is feminine when it only conveys the numerical idea of two persons or things of the same kind accidentally put together, without any idea of feeling, participation, or common purpose between them; as,

A couple of pigeons (meaning two pigeons), *une couple de pigeons*.

A couple of families, *une couple de ménages*.

A couple of horses, *une couple de chevaux* (meaning only two horses, without the idea of their forming a team).

Délice, delight.—*Délice* is masculine in the singular, and feminine in the plural; but for the sake of euphony we say, *Un de mes plus grands délices*, One of my greatest delights, with *grands* in the masculine, because it would be shocking to meet in the same proposition with two adjectives of different genders, relating to the same noun.

Enfant, child.—*Enfant* is masculine when it designates a boy, and feminine when it points out a girl.

Exemple, example, copy.—*Exemple* is now used in the masculine, whether it signifies an *example* or a *copy*.

Foudre, thunderbolt, vengeance, fury, &c.—*Foudre* is feminine whenever it is used to designate a thunderbolt; it is of either gender, if it signifies the weapon of Jupiter. It is still feminine when used for *vengeance, fury, &c.*; as, *La foudre est dans ses yeux*; Anger is in his looks.

Foudres in the plural, used metaphorically, and signifying either pieces of cannon, celestial anger, or excommunication from the court of Rome, is of either gender.

Foudre, applied to man, and signifying a great conqueror, a man who has gained many victories, is always masculine; thus we say, This general was a thunderbolt of war, *Ce général était un foudre de guerre*.

Speaking of a great orator, we also say, *C'est un foudre d'éloquence*.

Gens, people, men.—*Gens*, people. This word in the plural is masculine when followed by an adjective; as, They are happy people; *Ce sont des gens heureux*. But it is feminine when preceded by an adjective; as, They are old people, *Ce sont de vieilles gens*. With *tout*, all, it is masculine, if that adjective is alone; as, All honest people, *Tous les gens de bien*.

When *tout* is followed by another adjective, *gens* is masculine provided that

adjective does not change its termination in the feminine; as, All honest people, *Tous les honnêtes gens*.

But it is feminine when the adjective changes its termination; as, All the old people; *Toutes les vieilles gens*.

However, usage requires, in order to show its despotism, that the pronouns and adjectives which refer to that word should be in the masculine whenever they are placed after it; as, Old people are troublesome; *they are good for nothing*; *Les vieilles gens sont ennuyeux*; *ils ne sont bons à rien*.

Hymne, hymn.—*Hymne* is feminine when it designates a song in honour to God; but it is masculine when it signifies a profane song in honour to pagan gods or heroes.

Jujube, jujube.—*Jujube* is masculine when it designates the paste made of that fruit, and feminine when it signifies the fruit itself.

Œuvre, work.—*Œuvre* is masculine when it designates a great work or enterprise; it is still of the same gender when it is used to signify such a work as a picture, an engraving, a statue, or a piece of music; but it is feminine when it is an act, whatever it may be, or some production of the mind; as, He does good deeds; *Il fait de bonnes œuvres*; Complete works of Racine; *Œuvres complètes de Racine*.

Orge, barley.—*Orge* is feminine in the singular and plural; the only two cases in which it is masculine are the following expressions; Pearl barley, *orge perlé*; Peeled barley, *orge mondé*.

Orgue, organ.—*Orgue* is masculine in the singular and feminine in the plural; but if preceded by *un de*, *one of*, it remains masculine in either number, for the sake of euphony; as in, *Voilà un des plus beaux orgues que je connaisse*; This is one of the most beautiful organs I know.

Pâques or *Pâque*, Easter day.—*Pâques*, a holiday among the Christians, is written with an *s*, is not preceded by the article, and belongs to the masculine gender.

Pâque, a holiday among the Jews, is written without an *s*; it takes the article, and is feminine. We also say in the plural, Palm Sunday, *Pâques Fleuries*; To receive the sacrament at Easter, *Faire ses Pâques*, *pâques* being feminine plural.

Parallèle, parallel.—*Parallèle* is masculine when it signifies a comparison; it is feminine when it designates a line as being parallel to another.

Pendule, pendulum, clock.—*Pendule* is masculine when it signifies *pendulum*, and feminine when it means a *clock*.

Période, pitch, period.—*Période*, when meaning *pitch*, is masculine, and feminine when it signifies a *period*.

Personne, a person, nobody, anybody.—*Personne* used as a noun is feminine, and masculine when employed as a pronoun.

Quelque chose, something.—*Quelque chose*, when followed by a verb in the subjunctive mood, is feminine; as in, *Whatever may be the thing he has done, or attempted to do, he has been unsuccessful*. *Quelque chose* qu'il ait faite ou entreprise, il a échoué.

In any other case, *quelque chose* is always masculine, on account of its vague and indefinite meaning; as, Give me something pretty; *Donnez-moi quelque chose de joli*; I will give you something good; *Je vous donnerai quelque chose de bon*.

Autre chose is masculine, also, when it conveys an indefinite meaning; as in, There is some other news; *Il y a autre chose de nouveau*; but it is feminine when it has a definite meaning; as in, This is another thing still more wonderful; *C'est une autre chose encore plus merveilleuse*.

Régliste, liquorice.—*Régliste*, a plant, is feminine; *Régliste*, a paste, is masculine.

Sentinelle, sentry.—*Sentinelle* in prose is always feminine, but in poetry it is of either gender.

Trompette, trumpet.—*Trompette* is masculine when it designates the individual who plays on that instrument, and feminine when it signifies the instrument itself.

(To be continued.)

HE that is wise will take delight even in an ill opinion that is well-gotten. 'Tis ostentation, not virtue, when a man will have his good deeds published; and 'tis not enough to be just where there is honour to be gotten, but to continue so, in defiance of infamy and danger.—*Seneca*.

SYSTEM OF ELOCUTION.

(Continued from page 170).

GESTURE.

GESTURE is the various postures and motions employed in vocal delivery: as the postures and motions of the head, face, shoulders, trunk, arms, hands, fingers, lower limbs, and the feet.

Graceful and appropriate gesture renders vocal delivery far more pleasing and effective. Hence its cultivation is of primary importance to those who are ambitious of accomplishment in Elocution.

Postures of the Body.—The postures of the body, with respect to vocal delivery, may be divided into favourable and unfavourable; and, the better to suit my purpose in giving their illustration, I shall first treat of the unfavourable.

The most unfavourable posture is the horizontal. If a reader or a speaker should lie prone, or supine, he would not be likely to deliver a discourse with energy and effect. I have never known an *orator* to deliver a discourse in the horizontal posture; but I have known individuals to speak in public in postures almost as inappropriate.

The human mind is so constituted, that, in its education, order becomes almost indispensable. Hence, any thing that interrupts methodical instruction, is a serious obstacle to the growth of intellect. Nor is order more necessary than perseverance; consequently, all postures of the body which are calculated for repose, should be avoided by the student in elocution. And as grace and dignity are of primary importance in vocal delivery, all postures which are inconsistent with these attributes should also be avoided.

The erect posture of the body is the best for vocal delivery; the trunk and limbs should be braced in proportion to the degree of energy required by the sentiments to be delivered. The right foot should be from two to four inches in advance of the left, and the toes turned a little outwards; meanwhile, the body should be principally sustained by the left foot.

The next best is the *erect* sitting posture, in which the shoulders do not rest against the back of the seat, and in which

the body is retained in its proper position by muscular action.

The next best is the *erect* sitting posture, in which the shoulders rest against the back of the seat.

These are the only postures which are at all favourable to vocal delivery.

Manner of holding the Book.—The book should be held in the left hand, from six to eight inches from the body, and as high as the centre of the breast, so as to bring the face nearly perpendicular. It should not, however, be held so high as to prevent the audience from having a view of the reader's mouth, as his voice would thereby be more or less obstructed. The fingers of the right hand may take hold of the margin of the book lightly, so as to be ready to turn over the leaves, as occasion may require; or they may be placed upon the page, just below the line the reader is pronouncing, to aid him in keeping his place; or, particularly if the reader is pronouncing an original composition, the right hand may be employed to illustrate and enforce the sentiments by appropriate gesticulation. If the reader be a lady, the right hand may support the left arm. I do not, however, advise ladies to adopt this posture exclusively, but deem it not ungraceful for them.

The eyes should occasionally be directed from the words of the discourse to the audience.

In demonstrating on the black-board, the face, and not the back, should be turned to the audience.

Notation of Gesture.—The want of a language for expressing the different modifications of gesture with brevity and perspicuity, is the principal cause of the general neglect with which the cultivation of this art has hitherto been treated. For this desideratum the world is indebted to the Rev. Gilbert Austin, of London. In 1806, this distinguished elocutionist published a quarto volume of six hundred pages; and from that work I have taken the system of notation of which the following is a specimen:

When the right arm is elevated backwards, and the left extended forwards, in a horizontal direction, he calls the posture of the former *elevated backwards*, and notes it *eb*; and the posture of the latter, *horizontal forwards*, and notes it *hf*. Now

the abbreviations *eb* and *hf* are placed over any word which requires these postures of the arms, thus :—

eb—hf
"Jehovah's arm
 Snatch'd from the waves, and brings me to
 my son !"^{*} *Douglas, Act III.*

The original idea of this system of notation, says Mr. Austin, was suggested by the labour of teaching declamation in the usual manner. During this labour, which for many years constituted a part of his duty in his grammar-school, the author having often found that he forgot, on a following day, his own mode of instructing on a former, wished to be able to invent some permanent marks, in order to establish more uniformity in his instructions, for the ease both of himself and of his pupils. The mode of instruction is not so liable to change, with respect to the expression of the voice and countenance, for this is always pointed out by the sentiment. But the great difficulty lies in ascertaining and marking the suitable gesture; and for these obvious reasons; because a language of gesture was wanting, and because gesture may be infinitely varied, and yet, perhaps, be equally just. To leave the pupil to choose for himself would but distract him, and, instead of giving him freedom and grace, would deprive him of both. On his commencement as a public speaker (which cannot be too early), it is necessary to teach him everything, and to regulate, by rules, every possible circumstance in his delivery; his articulation, accent, emphasis, pauses, &c., and along with all, his gesture. After sufficient instruction and practice, he will regulate his own manner, according to the suggestions of his judgment and taste.

Among the higher objects of this system of notation, may be reckoned its uses as a record, whence the historical painter may derive the materials of truth, and whence the orator and the elocutionist may not only obtain the instructions of the great men who have preceded them in the same career, but by which also they may secure unalterably their own improve-

ments for the advancement of their art, and for the benefit of posterity. A scene of Shakspeare, or a passage of Milton, so noted, after the manner of a great master of recitation, or an oration so noted as delivered by an admired speaker, would prove an enduring study of truth and nature combined with imagination. And the aspiring orator would not be obliged, as at present, to invent for himself an entire system of action. He might derive light from the burning lamps of the dead, and proceed at once, by their guidance, towards the highest honours of his profession.

Had the ancients possessed the art of notating their delivery, such was the unwearied diligence of their great orators, Demosthenes and Cicero, that we should, most probably, at this day, be in possession of their manner of delivery, as well as the matter of their orations; and not be limited to conjecture relative to a single sentence of these eminent speakers, on the great occasions which called forth their powers.

HAPPY EFFECTS OF EDUCATION.—

The tendency of knowledge is, and the tendency of its diffusion undoubtedly is, to improve the habits of the people, to better their principles, and to amend all that which we call their characters: for there are a host of principles and feelings which go together to make up what we call, in the common acceptance of the words, the human character. How does this diffusion operate? To increase habits of reflection, to enlarge the sphere of the mind, to render it more capable of receiving pleasurable emotions, and of taking an interest in other, and in higher and better matters than mere sensual gratification. It tends to improve the feelings, as well as to increase the reflective habits; and it tends, therefore, to the attainment of that which in itself tends immediately and directly to improve the character and conduct of a nation. It tends to increase prudence and prudential habits, and to amend and improve the human feelings. The ancients have described the effects of education in far better language, and much more happily than I can do—"emollit mores, nec sinit esse feros."—Brougham.

^{*} Although an explanation of the gestures on *Jehovah's arm* in the above sentence, is sufficient to answer my present purpose, it may not be improper to inform the reader that another gesture is required on the word *son*.

LESSONS IN DRAWING.

THIRD LESSON.

(Continued from page 172.)

HITHERTO your efforts have only been directed towards the formation of straight lines, and figures formed by means of them; but you must now turn your attention towards the drawing of curved lines.

Unless you can draw a curved line accurately, in any direction, you can never hope to delineate the human figure or animals in a proper manner; for the outlines of both the animal and vegetable kingdoms are made up of curved lines of every variety. It is needless to give a long list of examples; the student will easily observe them in the objects around him, from the horse to the cat or diminutive mouse; or from the gay butterfly that soars above him, to the gnat, from which it has been transformed; or from the lofty oak to the humble acorn: but we are anticipating, and must therefore proceed at once to the object of this lesson.

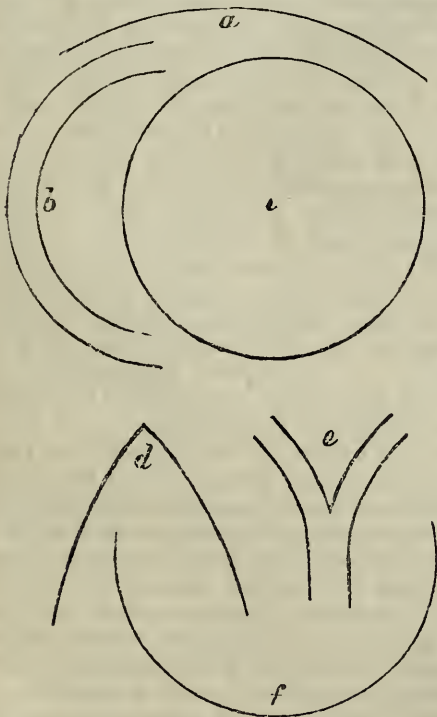


Fig. 10.

Commence practising the formation of curved lines, by drawing several like

(a fig. 10,) and then, when you are able to do so, accurately and easily, draw parallel lines with a greater curve, as (b fig. 10). When you can enlarge these copies upon a black board, with a piece of chalk, or reduce them with a pencil upon paper, then you may venture to draw a circle like (c fig 10).

To draw a circle.—Perhaps one of the most difficult tasks for the beginner is to draw a circle; but like everything else, it is easily done when you know how to set about it. Commence the task by making a faint dot upon the paper to mark the centre; then place another dot on either side of it and at equal distances, and continue placing dots at equal distances all around the central one, until a circle of dots is formed; you must then join all the dots with a steady and slow sweep of the hand, beginning at the top of the circle, and drawing from left to right, and right round to the point from which you started. Practise this several times, as it will give you precision, and enable you to observe the relative distance of the outer part of the circle from the centre. Keep these copies, whether they be good or bad, and when your lesson is finished, test the correctness of your marks or dots, by means of a pair of compasses; but do not attempt to use compasses to draw a circle. They will not assist you; on the contrary, when you are without them, you will be at a loss, and unable to accomplish your object. Persevere, and practise continually, and your labours will be rewarded.

When you have drawn a few dozen circles by the aid of the dots, draw some without making any marks upon the paper or board; sometimes drawing from left to right, and at other times, from right to left.

Draw one circle within another, so that their margins shall be parallel, as in the portion of one shown in b fig. 10.

Draw a semicircle, as f in fig. 10, and then practise forming d and e in the same figure, until you can *join lines* neatly, sometimes commencing from the lower part of the figures, and at other times, from the upper part.

Divide circles into sections, so as to exhibit the half, a quarter, a third, or other divisions of a circle.

Draw squares, polygons, and triangles within circles, and then construct a circle within a square.

Copy the following figure, and then



Fig. 11.

proceed to draw the three following outlines, which you will no doubt do correctly and readily, from the practice you have already had in the curved lines. Be

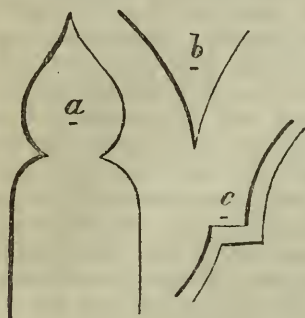


Fig. 12.

careful in copying *a* and *c*, to make the left hand lines darker than those to the right, while *b* has lines of each breadth. It is well to use the pencil marked HB for this purpose, the different thickness of the lines being produced by the degree of pressure employed.

STATISTICS OF BOOKS.—D'Israeli, in his "Curiosities of Literature," states, that the four ages of typography have produced no less than 3,641,960 works! Taking each work at three volumes, and reckoning each impression to consist of only 300 copies (a very moderate supposition), the actual amount of volumes which have issued from the presses of Europe, down to the year 1816, appears to be 3,277,640,000!

THE HABIT OF ATTENTION.

AN early and unremitting zeal in forming the mind to a habit of *attention* not only produces the outward expression of good breeding, as one of its incidental advantages, but involves, or rather creates better qualities than itself, while vacancy and inattention not only produce vulgar manners, but are usually the indication, if not of an ordinary, yet of a neglected understanding. To the habitually inattentive, books offer little benefit; company affords little improvement; while a self-imposed attention sharpens observation, and creates a spirit of inspection and inquiry which often lifts a common understanding to a degree of eminence in knowledge, sagacity, and usefulness, which indolent or negligent genius does not always reach. A habit of attention exercises intellect, quickens discernment, multiplies ideas, enlarges the power of combining images and comparing characters, and gives a faculty of picking up improvement from circumstances the least promising; and of gaining instruction from those slight but frequently recurring occasions, which the absent and the negligent turn to no account. Scarcely anything or person is so unproductive as not to yield some fruit to the attentive and sedulous collector of ideas. But this is far from being the highest praise of such a person; she who early imposes on herself a habit of strict attention to whatever she is engaged in, begins to wage early war with wandering thoughts, useless reveries, and that disqualifying train of busy, but unprofitable imaginations, by which the idle are occupied and the absent are absorbed. She who keeps her intellectual powers in action studies with advantage herself, her books, and the world. Whereas they, in whose undisciplined minds vagrant thoughts have been suffered to range without restriction on ordinary occasions, will find they cannot easily call them home, when wanted to assist in higher duties. Thoughts, which are indulged in habitual wandering, will not be readily restrained in the solemnities of public worship or of private devotion.—*More.*—[We recommend these excellent remarks to the especial notice of our pupils.]

THE MONTHS.—APRIL.

(Continued from page 207.)

THE beauties of this season are enticing us to wander forth in the meadows and "wild-wood bowers," and indulge in reading the illuminated pages of Nature's instructive book, for

"The primrose and cowslip are out,
And the fields are with daisies all gay;
While the butterflies, flitting about,
Seem glad in the sunshine to play.
Not more glad than the bee is to gather
New honey to store in his cell;
He, too, is abroad this fine weather,
To rife cup, blossom, and bell.
The goldfinch, and blackbird, and thrush,
Are brimful of music and glee;
They have each got a nest in some bush,
And the rook has built his on a tree.
Oh! who would be sleeping in bed
When the skies with such melody ring—
When the bright earth beneath him is fed
With the beauty and fragrance of Spring."

How calm and beautiful is the scene around us! How refreshing and cheerful! Let us ramble among the variegated parterres, the budding woodlands, and luxuriant meadows, to contemplate the many interesting objects of natural history peculiar to the month.

Ah! there is the scentless dog violet (*Viola canina*), that attracts the eye as it shakes its large flowers in the breeze; and near to it is the wild pansy, or heart's-ease (*Viola tricolor*), "the garden's gem," which seems to say, "Think of me." Its little purple or yellow flowers, with purple streaks, or its softening pale yellow petals, peep unobtrusively from amid its clustering leaves, and

"Pray you, love, remember;
There's pansies—that's for thoughts."

Look at yon hedge of black-thorns (*Prunus spinosa*), or early sloes, emblematic of difficulty. How beautiful its white blossoms look amid the dark branches, devoid of leaves. It may well be called "the snow of spring." The fruit of the sloe is harsh and unwholesome unless preserved; nevertheless, it is extensively cultivated for its fruit and its leaves, which appear after the tree has gladdened us with their blossoms; the former is used to adulterate port wine, and the leaves to adulterate tea. How the beautiful blos-

soms of the Siberian crab (*Pyrus prunifolia*) contrast with the snowy wreaths of black-thorns beneath! Well may Elliott have written

"What virgin's cheek
Can match this apple-bloom?"

There are few school-boys but what remember its pretty-looking, cherry-like fruit. How often they have been enticed by their appearance and deceived by their flavour!

What beauties surround us! There is the perfumed cherry-tree (*Cerasus Mahaleb*), with its grateful perfume, the wood of which is used for furniture by the French, on account of its durability, hardness, and cheapness; beyond we can distinguish the bird cherry (*Prunus padus*); the common almond tree, which we noticed last month; and several species of ornamental pear (*Pyrus nivalis*), with snow-white blossoms; and the downy-leaved pear (*P. salvifolia*).

Our wanderings have brought us to a clump of speedwells, some wild and others captured from native freedom. There is the ivy-leaved speedwell (*Veronica hederifolia*), with its thick green leaves, resembling the ivy; if its bright blue flowers were out, how pretty it would look. But we cannot complain, for the grey field speedwell (*V. agrestis*), with its notched leaves and small blossoms, welcome us to the spot. The eyebright's blue petals made Elliott exclaim, that it was the

"Loveliest flower of all that grow
In flower-loved England! Flower whose hedge-
side gaze
Is like an infant's!"

Oh! how often as children have we wandered along the lanes near the "old house at home," and gathered the germander speedwell (*V. chamaedrys*), or "Paul's betony," cat's-eye, or eyebright! We remember, one beautiful evening, making a wreath of wild flowers for a young nymph, who rivalled them in beauty and sweetness, and there was only one flower—the speedwell—that contested for the victory. 'Twas a hard battle, but the flower lost, and we have ever loved the speedwell since then; it seemed to grace the maiden's brow amid the many flowers displayed,

'But still, 'midst all this gorgeous glow,
Seemed less of sweetness than of show."

On yon wall is another speedwell, the *Feronica arvensis*, and the common species (*V. officinalis*), which flowers in May, will be found in the pastures or yon wild woods.

Look at that beautiful clump of lilac trees, the pride of the humble cottager, the farmer, and the nobleman. Who would fancy that this simple tree was a native of Persia, and yet it withstands the vicissitudes of our changeful clime. Poets have celebrated its beauties, and painters have despaired when attempting to depict its delicate hues, for the lilac is

“Various in array, now white,
Now sanguine, and her beauteous head now set
With purple spikes pyramidal, as if
Studious of ornament, yet, unresolved
Which hue she most approved, she chose them
all.”

Many varieties of lilac are to be seen in our garden; for example, the Persian lilac (*Syringa Persica*), with its fragrant clusters of flowers and long pointed leaves; the blue lilac (*S. vulgaris cœrulea*); the common lilac (*S. vulgaris*); and the purple lilac (*S. vulgaris violacea*); all of which were no doubt introduced during “Bluff Harry’s” reign.

What are those pale lilac flowers bending beneath the breeze in yon meadow? Why, they are the cuckoo-flower (*Cardamine pratensis*); and just by the wooden fence you may see the starch grape hyacinth (*Muscari racemosum*), which is more usually found among ruins, where its dark purple flowers nod to the mossy walls, than in our gardens.

Here is a mound, with stalactites, shells, and stones rising in its centre, and various flowers, wild and cultivated, entwining themselves in the fanciful pile. Ah! there are the Eastern hyacinths (*Hyacinthus orientale*); some have pink, some pale blue, and others white flowers, but there is no limit to colour and variety, which vary with clime and time. Yonder is the feathered hyacinth (*Muscari comosum monstrosum*), which looks so stately amid its long narrow leaves. There is the ground-ivy (*Glechoma hederacea*), with its kidney-shaped leaves, and square, rough stem, winding among the rock-work, and trying to outvie the pretty little Greek valerian (*Polemonium reptans*), with its light blue flowers; and its companion, Jacob’s lad-

der (*P. cœruleum*), which will bloom next month.

Here is a beautiful cluster of flowers of all kinds.

“Come along, come along, and guess with me
How fair and how fruitful the year shall be!”

Look at the pretty little daisy (*Bellis perennis*), emblem of innocence, which opens at day-break and closes at sunset:

“That old favourite—the daisy, born
By millions in the balmy, vernal morn—
The child’s own flower.”

See how it tempts us to stop in our ramble and gaze upon its “silver crest and golden eye,” as it peeps from the greensward. It is the loved flower of our youth and old age. Yes! we love to see that

“Wee, modest, crimson-tipped flower,”

which Chaucer calls the “eie of the daie;” the same flower that Spenser mentions as

“The little daizie, that at evening closes.”

As children we remember many varieties of this plant, some of them long since forgotten,—but others have taken their place; for, although

“Trampled under foot,
The daisy lives, and strikes its little root
Into the lap of Time.”

The annual daisy (*B. annua*), and the Portugal daisy (*B. sylvestris*), are staring at us from that clump of flowers we have been so long approaching.

Are not the saxifrages looking pretty, with their showy foliage and blossoms? See the pyramidal saxifrage (*Saxifraga cotyledon*); it will not blossom until June, but there is the thick-leaved saxifrage (*S. crassifolia*), with its large purple blossoms, and so planted that it affords relief to the others, which in turn will attract the rambler’s gaze to their own showy flowers. We cannot name all the species of this plant, as they are too numerous; but there is our old favourite, the London pride (*S. umbrosa*), the hardiest of the whole, which some persons call “none-so-pretty;” it is considered the emblem of frivolity. Next to it is the saffron-coloured saxifrage (*S. mutata*), which grows wild in Italy and Switzerland; and the round-leaved saxifrage (*S. rotundifolia*), which will not bloom yet. It comes from Piedmont, where the natives eat it.

Look at the centre of yon clump, where the Swedish dogwood (*Cornus suecica*); the yellow alyssum (*Alyssum saxatile*); the fumitory (*Fumaria officinalis*), with its deep purplish, rose-coloured flowers; the double furze (*Ulex Europæus*), with fragrant blossoms; and the pasque flower (*Anemone pulsatilla*), rear their heads above the sweet-scented meadow clover (*Trifolium pratense*); the white Dutch clover (*T. repens*), which is generally considered to be the trefoil, or shamrock, of the Irish; the hop trefoil (*T. procumbens*), with its oval, hop-shaped, yellow blossoms; and the strawberry-headed trefoil (*T. fragiferum*), with its red flowers, contrasting with the common little yellow trefoil (*T. filiforme*); and the hare's-foot trefoil (*T. arvense*).

Yonder is the common wallflower (*Cheiranthus cheiri*); the gentianella (*Gentiana acaulis*); the bulbocodium (*Ixia bulbocodium*); the Robert-leaved crane's-bill (*Geranium Robertianum*), with its pink flowers; the ragged crane's-bill (*G. dissectum*), with its deeply jagged leaves; and the spring snow flake (*Leucojum vernum*). How beautiful they look near the horn-flower (*Calla Ethiopica*); the early scorpion grass (*Myosotis collina*); the Venus's looking-glass (*Campanula speculum*), with its peculiar-shaped flowers; and the corn pink (*C. Lorei*), another kind of Venus's looking-glass.

Oh! how beautiful the spiræas look! See the meadow-sweet (*Spiræa ulmaria*); the smooth-leaved spiræa (*S. levigata*); the goat's-beard (*S. aruncus*); the Italian May (*S. hypericifolia*) with its sweet little white flowers glimmering among the dark leaves; and the dropwort (*S. filipendula*).

Yonder are the yellow cowslips (*Primula veris*); the yellow tulip (*Tulipa sylvestris*); the yellow oxlip (*Primula elatior*); the butter bur (*Petasites vulgaris*); the bear's-ear (*Auricula ursi*), an old kind of auricula, which may now be seen mingled with many varieties of this much-prized plant:

"enriched
With shining meal o'er all their velvet leaves,"
particularly the *auricula primula*.

Here is a pleasing cluster of shrubs and flowers. The sweet bay (*Laurus nobilis*); the common laurel (*Prunus laurocerasus*); the red-flowered black currant (*Ribes san-*

guineum), from California's wilds; the wax-leaved currant (*R. cereum*), the leaves of which are coated with a wax-like substance; the snowy-flowered gooseberry (*R. niveum*), with its beautiful little wax-like bell-shaped corollas; the snowy mespilus (*Amelanchier Botryapium*); the box shrub (*Buxus sempervirens*) which we often see quaintly trimmed in country towns and villages; the common berberry (*Berberis vulgaris*), the fruit of which is used for garnishing dishes, or to make a refreshing drink for persons labouring under fever, and the root is used for dyeing yellow; and the guelder-rose (*Viburnum opulus*), with its

"Silver globes, light as the foaming surf,"

are all collected in this spot, and overshadow the vernal squill (*Scilla verna*), which usually grows by the sea-side; the wood-sorrel (*Oxalis acetosella*) growing under the shade of the trees,

"with its light green leaves
Heart-shaped, and triply-folded; and its root
Creeping like beaded coral!"

Beyond that cluster of anemones is the stinking hellebore (*Helleborus foetidus*), with its large leaves and greenish-yellow blossom; and next to it is the green hellebore (*H. viridus*), both poisonous plants; and the rosemary (*Rosmarinus officinalis*), with its pale blue and variegated aromatic flowers and leaves.

I hear the skylark (*Alanda arvensis*), sweet songster of the clouds, and

"Bird of the free and fearless wing!"

emblem of happiness; and look on yon tree near the cottage door! there is the turtle-dove (*Columba turtur*), emblem of innocence.

If we rambled through the fields and lanes, and along the sea-shore or river's side, we should encounter many birds; for example—the crossbill (*Loxia curvirostra*); the aberdevine (*Carduelis spinus*); the field-fare (*Turdus pilaris*); the silvery gull (*Larus argentatus*); and the green-sand piper (*Totanus ochropus*.) These are all leaving our shores for more northern ones, where they will breed, and return in due time with their young ones to greet us again with their peculiar call-notes.

The swallows (*Hirundo urbica*, *H. rus-*

tica, &c.) are arriving from the southern latitudes, and with them the whin-chat (*Saxicola Rubeta*); the white-throat (*Curruca cinerea*); the wry-neck (*Yunx torquilla*); the black-cap (*Sylvia atricapilla*); the hay-bird (*S. trochilus*); the ring black-bird (*Merula torquata*); the quail (*Coturnix major*); and the ruff (*Tringa pugnax*.)

The angler looks up his fishing-tackle and betakes him to the rivers to indulge in his loved sport; but there is not much variety of the finny tribe to be seen now. The rud (*Barbus orfus*); the barbel (*B. communis*); and the stone roach (*Gobitis barbatula*) spawn during the month.

The entomologist with his pockets filled with boxes, bottles, quills, and other apparatus, not forgetting pins, saunters along the lanes and meadows, now turning over an old stone to capture a beetle, at another time diving his net into a pond for the same purpose, and then dropping his boxes, he takes up his gauze net and chases the butterfly over the dewy meadows. How eagerly he looks out for the early cabbage-butterfly (*Pontia brassicæ*); the speckled wood-butterfly (*Hipparchia Aegeria*); the Kentish glory (*Endromis versicolor*); the small copper-butterfly (*Lycæna Phlæus*); the turnip-butterfly (*Pontia Rapæ*); the early turnip-butterfly (*P. metra*); and the wall-butterfly (*Hipparchia Megæra*.) Nor is he less anxious after the moths, as he seeks for the humming-bird hawk-moth (*Macroglossa stellatarum*); the gamma moth (*Plusia gamma*); the Marvel-de-jour moth (*Muselia Aprilina*); the emperor moth (*Saturnia pavonia*); the angle-shades moth (*Phlogophora meticulosa*); and the 20-plume moth (*Alucita hexadactyla*.) The beetles or coleopterous-insects abound now, and among these he will find the catch-weed beetle (*Timarcha tenebri-cosa*); the burying-beetle (*Necrophorus sepulchror*); the garden-beetle (*Carabus hortensis*); the death-watch beetle (*Anobium tessellatum*); the elm-destroying scolytus (*Scolytus destructor*); and the timber-beetle (*Cerambyx violaceus*.)

The quadrupeds of the month are the fox (*Canis vulpes*); the house cat (*Felis maniculata*); the martin (*Martes fagorum*); and the polecat (*Mustela putorius*.)

The reptiles are the toad; the natter-jack (*Bufo rubeta*); the common frog (*Rana temporaria*); the eft (*Triton palustris*),

all of which spawn early in the month; and the snake (*Natrix torquata*.)

What a vast field for observation is open to the naturalist, and the lover of Nature's beauties. Let the young learn to study the wondrous works of God around them, and daily to exclaim

"Grant me, my God! Thy voice to know,
And not to be afraid."

THE GOLDEN PEACOCK.

A STORY OF KING ARTHUR.

(Continued from page 176.)

Guinever, surrounded by her ladies, stood to welcome her lord, in all the splendour of her beauty, bareheaded, on a terrace constructed after the Italian fashion, in front of her own private apartments, on one side an inner court, which her taste had decorated with images and flowers. King Arthur rode to her, and, pointing to Mordred, surrounded as a prisoner by a group of knights, "Look," said he, "knowest thou this recreant?"

Guinever turned pale, and a frown darkened her fair face as Mordred knelt before her.

"Bright queen," said he, "look on me in compassion; I came here of my own free will, repenting of my past errors, and hoping forgiveness through your gracious intercession."

"Without which he dies," said Arthur. "Speak his fate—it rests on your word."

"No, surely, my good king," faltered Guinever, "this were too painful—unjust, indeed."

"I have said it, and it shall be done. At your request alone will I spare his life."

Guinever was silent some moments, and her penetrating eye read in the abject submission of the traitor what was its true nature and object; but then her husband's face revealed his expectation and his hope that she would spare the friend he had loved so well. For Arthur's sake, then, only, reluctantly she spoke the words of life, though with undisguised contempt.

"Let him live if he covets life." She turned to withdraw into her apartments, but Arthur, his heart yearning for his fallen cousin, again requested her to decide whether Mordred were to remain

a prisoner, or to be permitted to re-enter the knightly circle; at the same time reminding her, that as Christian people they were bound to forgive one who was truly repentant. Saying, also, that he had come of his own free mind, and, therefore, should not meet with the same treatment as if a prisoner by force of arms.

"My king," said Guinever, "*you* have still trust in Mordred,—then let him *prove*, by the faithfulness of his future service, the reality of his penitence."

"Give him place, then, once more, warriors of the round-table," said Arthur; "try his good faith."

"And who is to be answerable to the country if he betray us to Cerdic?" said a chief, who looked on the pardon of Mordred with undisguised amazement and indignation. "O, my good king, this must not be told abroad, that you admit an open traitor to our company."

"I will be answerable for him," said Arthur, soothingly; "come with me, Mordred, and let me hear from your own lips your own views of these strange doings, by which you have forfeited your honourable place among us."

Mordred followed his cousin into a private chamber in the castle, and they were long in private conference. Mordred was seen no more after that for some days, when he re-appeared in command of a small troop of horse soldiers, whom Arthur had persuaded to serve under him. As for all the rest of the fraternity of the round-table, they decisively refused to acknowledge Mordred as their leader. But he scorned public opinion, and only longed for an opportunity of revenge for the contempt. The ladies of Queen Guinever's court also looked coldly upon him, and she herself made it apparent to him that his presence was unwelcome. His manners had never been popular; there was a cold, self-importance about him, and an indifference to the opinions, the sentiments, and the interests of others, that made him generally disliked. There were, also, worse impressions current of him. But it occurred to king Arthur that Mordred's character and position might yet be retrieved, though at some cost to himself; for Mordred had made him believe that his lapse from duty had been caused by temporary irritation of mind, excited by many

disappointments. Lotho, his father, had left his own petty kingdom of Strathelyde to his eldest son; thus excluding Mordred, who was left without inheritance or provision, but what he might obtain from the favour of his brother and king Arthur. Hitherto his position had been unsettled and unsatisfactory; and this, he said, together with the failure of his suit to Guinever, had driven him to desperation; but let Arthur assign him a portion of his territories, where he might rule independently of all (excepting his homage to Arthur as emperor), and Britain should find that he knew how to grace the throne. But as he now was, he felt miserable, because he was humiliated and dependent. Arthur adopted these views, and agreed to assign to Mordred the province of Cornwall, as a permanent kingdom for himself and his heirs, reserving, however, the fortress of Tintagel, his own favourite abode. In making this settlement Arthur displeased many; but the act appeared to himself just and right, while Mordred exulted in his success, and took upon himself the state and style of king of Cornwall.

PART II.

— "He which for the faith twelve famous battles fought."
DRAYTON.

ARTHUR and his army approached the strong and beautiful city of *Lindum Colonia* (Lincoln), which had been an important station of the Romans, and of the British after the Romans had left the island. Descending the hilly road, just before reaching the most advanced post of the Saxons, who were entrenched in Lindum, there burst upon the fiery glance of Arthur the valley of the river Witham, and the city-crowned hill beyond, Roman edifices of classic beauty, far-stretching Roman walls,—now bristling with Saxon spears,—churches,—both Roman and British, half consumed with fire,—and, chief of all, the fortress where Cerdic's Pagan standard darkly floated over the tallest of the towers that guarded the ramparts. The sight of these objects, and especially of the smouldering churches, roused all the enthusiasm and all the genius of Arthur. Addressing his troops in brief and stirring words, bold, buoyant, even gay, he bade

them take the castle and the city ere nightfall, and to-morrow re-build the churches, or, if not, to die fighting for the faith of God, the freedom of Britain, and the honour of the "Golden Peacock." Answering shouts of the company of the Round Table had scarcely borne the dread name of "Arthur!" to the startled ears of the soldiers of the Saxon outposts, ere they were forced by himself and his company, and every man guarding them put to the sword. Then the British army pressed fiercely on toward the Castle, whence issued Cerdic, the Mighty and Terrible, with a band of powerful Saxons. The battle was fierce and long-contested; it seemed uncertain which side might win; but Arthur withdrawing a part of his company under the guidance of Merlin, chief of the order of British Bards, entered the castle by a subterranean way, which was unknown to the Saxons, and the garrison found itself attacked at once from within and from without. "Merlin is here!" exclaimed the flying or perishing Pagans. "Where is Merlin, dastard?" demanded the savage Cerdic, striking to his feet one of the fugitives. "He is in the castle, aiding Arthur; he is a magician no one can fight against; he works great wonders for our overthrow," replied the Saxon.

The battleaxe of Cerdic silenced the speaker, just as the victorious cries of the Britons rang through the castle and city. Then were the Saxons slain on every side. But Cerdic escaped, no one knew how save Mordred.

That the Saxon chief was nowhere to be found clouded the triumph of Arthur.

Guinever had followed her husband to the siege of Lincoln, and was left in the charge of a trusty chief, a few personal attendants, and twenty men-at-arms, in the hut of a peasant, a little in the rear of the army, during the attack upon the city. The men-at-arms surrounded the hut. Often she went to the door, listening with intense anxiety to the distant sounds of the battle. Her face was stony pale when the first messenger arrived from Arthur,—from the midst of the battle,—to tell her the victory was sure, though not yet complete. "And is my king unharmed?"—"He is." Guinever clasped her hands in silent thankfulness. "Tell him," she said, "Guinever prays for him.

And give him this token of my love," tearing off an amulet from her arm. That messenger returned to Arthur, and reported her words, giving him the amulet, which he kissed and placed around his own right arm; then he said to Mordred, who was on horseback by his side in the street, where the dead and the wounded lay scattered in every direction,—some singly, some in heaps, and where the work of death and hell was still going forward,— "Go thou to her, and tell her the victory is accomplished, but my mind is troubled because our prime foe has escaped; say I am taking measures to discover where he is hid, as I know he must be somewhere in the city; desire her, as she loves me, to stay quietly where she is, until the city is calm, and I have prepared for her reception." Arthur had a bronze dagger of elegant workmanship in his hand; he gave it to Mordred for Guinever; and saw his cousin ride away as fast as the encumbrances on the ground would permit him. Through the whole night after Arthur continued busily directing the search for Cerdic, having the bodies of the slain examined and hastily buried, the buildings scrutinised within and without, and watches set along the fortifications. Every living Saxon found in the city he ordered to be put to death,—for he was now, as it were, drunk with the maddening Wine of War, which, in every age, has transformed men to fiends. As in savage animals, so in men, the thirst of blood is easily excited. Towards morning even the prodigious energies of Arthur were exhausted, and, solacing himself with the belief that Cerdic must be among the slain, though unrecognised, he lay down in his armour, throwing aside his helmet merely, and sank into a deep sleep,—but first, ever mindful of Guinever, he despatched Merlin, the Prophet Bard, to inform her how matters progressed.

When Arthur awoke, the bent and wasted form of the British seer, with long white beard, shining bald head, and flowing robe of black, was still before him, sitting mournfully, as in earnest thought, with eyes cast down. When Arthur arose, he also stood up. "Ah, Merlin!" exclaimed the king, "hast thou returned; how is my fair love?" Merlin slowly replied, "The soldiers you left to guard the queen were

sent away by Mordred, to assist in the search for Cerdic. The queen left the hut several hours ago, to come to you, and her guard on the way were Mordred and the troop you sent with him."

"I sent no troop with Mordred," loudly rejoined Arthur. "I sent him to bid her stay where I left her, until the search for the Saxon chief was over. I gave no orders for the changing of her guard. Where is she now?—and where is Mordred? You do not answer. You turn away."

"Nothing has been seen of him, or the queen, or the soldiers who accompanied them, since they left the hut."

"O, infatuated fool that I was," groaned the king, dropping on his couch, struck to the heart, "O Mordred! Guinever was right. She saw the evil nature in him, but I could not. Some spell has been on me,—some fatal enchantment has struck me blind. Summon my guard. We must follow the villain; but O! whither,—in what direction,—canst thou not advise? Why stand silent? Hast thou no divination to show where Mordred is gone with my queen? if not, be silent evermore. Call thy boasted art a mockery and a cheat. Speak, divine, pronounce, unfold the mystery, or out of my sight!"

"King," said Merlin, "years ago I warned you of this man."

"You did,—but I loved him as my own soul. Why we were babes together, of the same age,—our sports were the same; we slept in one bed, we ate at one board."—"He ever envied you; he is, and has been, and will be to the last hour of his life, your mortal enemy. It is written so in the book of destiny. But you have challenged my divination. I will show you Guinever and Mordred; you shall see them as they are, and where they are, at the next midnight, if thou wilt restore to the Druid order their ancient privileges."—"I will hang him up before then," cried Arthur, striding out of the chamber. Merlin heard him calling fiercely to his soldiers, and beheld his gigantic figure mounted on his famous war-horse, black as the thunder-cloud, gallop away, followed by a number of the chiefs of his Round Table. Away, away they rode; but Merlin shook his head ominously, and folded

his arms, and betook himself to solitude, in preparation for the midnight. As he foresaw, the king and his company returned unsuccessful. Then Merlin redeemed his promise. He brought, as it were, a cloud before the king in the midst of the hall,—and Arthur beheld in it, as through a veil, a Saxon tent, in which was a table covered with wine and provisions, and a number of persons were in the tent, among whom he recognised Guinever, looking affrighted, afflicted, and defiant, while Mordred handed to her a wine-cup, with humble and entreating gestures. Near them, also, was seen Cerdic, the Saxon chief, who, with animated countenance, appeared to be tracing on the palm of his left hand a military plan, which he was explaining to a group of soldiers, some Saxon, some British,—the latter well known to Arthur, deserters with Mordred.

"Accursed traitors!" burst from the lips of Arthur,—and at the sound the vision fled, and all that the king saw was Merlin stooping to light a brand at the fire on the hearth.

"Show me what is to come," said Arthur, impetuously; "let me look into the future?"

The seer elevated his wand, tracing mystic signs upon the air; a strain of mournful music exquisitely soft rose and died away, and Arthur discerned in the cloud a scene of touching beauty,—a green bank, overshadowed with trees, a verdant grave beneath, and a number of ladies dressing the grave with flowers. Amongst the ladies he saw the favourite attendants of his queen. The whole passed like a transient dream.

"Let me see more!" still urged the king;—"Show me something of my own destiny?"

Again the cloud appeared; and in it Arthur beheld a single lofty tower, surrounded by a deep ditch, and approached by a long flight of steps, irregularly steep and difficult.

"What meant that tower?" demanded Arthur, when the apparition had passed.—"What you have seen," replied Merlin, "you must interpret for yourself."

One mystic and awful vision more rises before the sight of the king, who gazes with indescribable feelings on a river of Cornwall, by whose romantic banks he had



often roamed with Mordred in their happy boyish days; he saw it flowing soft and beautiful as ever, under the shade of rocks and trees. But now he starts—his flesh creeps; a battle has been fought, and Mordred, his enemy, is there,—a broken sword in his hand, and a bleeding wound in his breast; and the hand that has slain him,—oh! whose is it?—surely king Arthur knows that shadowy form, lofty in stature, with a helmet of gold, wrought as a crown, and surmounted with the Golden Peacock; the face is turned away, but the figure of the son of Uther, chief of the Round Table, is not to be mistaken. Now it moves, half-turns,—and the point of Mordred's broken sword is perceived to be left

in the heart of his adversary, and they fade away together.—“Is this some demon's work?” exclaimed Arthur. “I'll see no more. Merlin, away! quit my sight!—be-gone! Thou art no good Christian. I fear thee much.”

“I go,” replied Merlin; “but, mark me, king, we meet thrice more,—at the grave of your Guinever, at the solitary tower, and in your last battle. Farewell!”

Shortly after the summoning trumpet called together the king's warriors of the Round Table. The well-known notes echoed far and wide over Lincoln streets and walls. The court of the castle was filled with a worthy company, hastily mounted and armed to meet their chief. He met them attended by his armour-bearers, his drawn sword glittering in his hand. “Brothers!” said he, “after eleven victories gained over our enemies, we should be able to hang our spears upon the wall, and sit down in quietness. But peaceful anticipations are at an end. You see me

oppressed with shame and sorrow,—with shame for Mordred, with sorrow for my queen. But I am less troubled for her dear sake than for his. For what is so bitter as the discovery of falsehood and base selfishness where we have trusted and loved? Her brave heart I know. She will find means to help herself,—God aiding,—as sure he will, for the sweet goodness of her whole life past. But that which strikes me with grief, which I shall everlastingly regret, is that the high cause for which we have so long stood in arms should now be placed in jeopardy by my want of discernment and infatuated folly. It is an injury I can never repair, though I would lay down my life at any moment to compensate for it. Mordred is gone from us, has assisted our enemy, Cerdic, to escape. The means are in his hands to do us mischief; he knows where we are weak, he can inform the enemy where we are strong. And, worst of all, he will give up to the Saxons all the places under his rule or influence. Can you, then, still confide in me as your leader? If not, speak out. Arthur can retire to a lower station, and yet strike good blows, I hope, for Britain.” Then answered Gawin, a gallant knight of the Golden Peacock, “I speak the mind of all here,—we will have no leader but thyself, king Arthur. As to Mordred, he shall yet die like a toad in a ditch, spurned, and trampled down. We will have him hunted to the world’s end. Let all the Saxons that ever the North Sea spawned on our coasts strive to protect him and it will be fruitless. Perish the pernicious traitor!”

Many a deep, manly voice, heartily echoed that malediction, and none more heartily than the king.

Meanwhile, the fair Guinever was in the power of Mordred and Cerdic; who, together with a number of Pictish and Celtic deserters from Arthur’s army, and a few Saxons escaped from the slaughter, hurried her and her attendants towards a strong post of the Saxons, situated some miles distant from Lindum Colonia. Her astonishment and indignation when she found that she was betrayed, were so excessive that she scarcely was conscious of fear, but looked and spoke with contemptuous defiance.

“I have long waited and watched for

this opportunity,” said Mordred,—“it has come at last. Proud, scornful Guinever, you refused my love, you would have seen me perish in Tintágel,—the gibbet or the sword was the mercy you designed for me. Now *my* hour of vengeance has come, and you shall feel it. I do not love you now as once I did, but with the love that is half hate, half revenge.”

While he spoke he pressed nearer and nearer to her, and she felt his hand grasp her shoulder; then flashed forth from her bosom the bronze dagger that Arthur had sent,—and though she spoke not, her firm gaze, her resolute attitude, made him fall back, and stand uncertain. “Dare to approach,” she said, “and you shall find I have not been king Arthur’s wife, without learning somewhat of his spirit. I am no weak girl that you can subdue in a moment. Look at the strength of this arm,” casting back the loose sleeve from her right arm, which was indeed of Amazonian development.—“I see its beauty,” said Mordred.—“I have worn armour in the service of king Arthur,” continued Guinever, “and can protect myself from any such as you.”—“Why was I not this beloved and applauded Arthur?” said Mordred, malevolently; “the bards sing that fairies blessed his birth, and gave him rarer gifts; to me they have only given disappointment.”

“All good spirits bless the good,” rejoined Guinever,—“but when wast *thou* good. Hath not thy falsehood been plain to me since first I knew thee? Thou hast long deceived the king,—the good and generous king that loved and trusted thee. How *couldst* thou do it? Base ingrate! I scorn thee from my soul.”—“’Tis very true,” said Mordred, grinding his teeth, “I have been false to him,—I hate him, and I rejoice this day to have wrung his heart by the loss of thee; and I will wring it more yet, drop by drop, for the wrongs he has done me.”

“Man, what wrong has Arthur ever done to thee?”

“Stolen my mother’s inheritance and mine,—stolen the applause of Britain, stolen *thee*!—robbed me of everything I coveted.”

“Has he not given thee part of his own kingdom?”

“Yes, to pacify me, as a mother paci-

fies a crying child by a gift; but that will not suffice me. Why has he reserved Tintagel,—why does he hold me down,—why does he carefully keep me from all real power and influence?"—"Why,—can you ask why, *traitor!*"—"Well, call me as you will; I was, and am, as you see, closely united with Arthur's foes, those who *will* aid me to my own advantage. Cerdic is my fast friend. I have conspired for him deep and wide; the heathen Picts, north of the Grampians, and the Scots, all your father's enemies, are advancing hitherward to join us, and I have secret reserves on every hand. Arthur *must* fall at last. Cerdic must, and shall rule in Britain. Cerdic and I,—for I will not be king of Cornwall only, but of the whole West,—and subject to no man."

Guinever's courage sank. "Consider what you are doing," she said; "restore me to the king without delay, and whatever cause of complaint you may have, or think you have, shall be patiently heard and redressed."

"Never," replied Mordred, "and let me warn you,"—his voice sank to a thrilling whisper—"Cerdic oft sacrifices his prisoners to the fierce fates of his religion."

A slight start, and a short cry of terror escaped Guinever; but quickly rallying, she loftily rejoined, "My reliance is on One who is above the fates. Besides, the Saxons durst not touch my life, considering who I am."

"Trust not that thought," said Mordred, impressively, "all that you are doth plead against you. The fairer and worthier, the fitter offering. The Saxon gods love fair and worthy victims. Stand you aghast? Well,—choose between me and Cerdic. Ah! you are placed between two fiery walls. There is no escape."

Guinever covered her face with her hands, and wept aloud. "As my prisoner," said Mordred, "I can and will protect you. Say but you accept my favour. Speak, dear queen! and cease to weep." "No, perfidious traitor!" exclaimed Guinever, "a hundred deaths rather." "You perish then—I sue no more:" and so saying Mordred abruptly left her, and she never saw him after.

(To be continued.)

WALTER SCOTT'S ADVICE TO HIS SON.

"I cannot too much impress upon your mind that labour is the condition that God has imposed on us, in every station of life. There is nothing worth having that can be had without it, from the bread which the peasant wins by the sweat of his brow, to the sports with which the rich man gets rid of his ennui. The only difference betwixt them is, the poor man labours to get a dinner to appease his appetite—the rich man to get an appetite for his dinner.

"As for knowledge, it can no more be planted in the human mind, without labour, than a field of wheat can be produced without the previous use of the plough. There is, indeed, this great difference, that chance or circumstances may so cause it that another shall reap what the farmer sows; but no man can be deprived, whether by accident or misfortune, of the fruits of his own studies; and the liberal and extended acquisitions of knowledge which he makes, are all for his own use. Labour, therefore, my dear boy, and improve the time. In youth our steps are light and our minds are ductile, and knowledge is easily laid up. But if we neglect our spring, our summer will be useless and contemptible, our harvest will be chaff, and the winter of our old age unrespected and desolate.

"Again:—Read, my dear son, read, and read that which is useful. Man differs from birds and beasts, because he has the means of availing himself of the knowledge acquired by his predecessors. The swallow builds the same nest which its father and mother built; and the sparrow does not improve by the experience of its parents. The son of the learned pig, if it had one, would be a mere brute, fit only to make bacon of. It is not so with the human race. Our ancestors lodged in caves and wigwams, where we construct palaces for the rich, and comfortable dwellings for the poor; and why is this, but because our eye is enabled to look back upon the past, to improve upon our ancestors' improvements, and to avoid their errors? This can only be done by studying history, and comparing it with passing events."

NATURAL PHILOSOPHY.

CHAPTER XXIV.

THE CENTRE OF GRAVITY.

Definition of the Centre of Gravity.—Line of Direction.—Position of Equilibrium.—Three Conditions of Support.—Resulting States of Equilibrium.—Stability of Bodies.—The Floating of Bodies.

IN every solid body there exists a certain point round which its material particles are arranged so as to be equally acted on by gravity. The gravitating forces soliciting these particles may be regarded as acting in lines which are parallel to one another; for the common point of attraction, the centre of the earth, is so distant, that lines, drawn from it to the different particles of any body on its surface, are practically parallel. To this point, thus found in every body, no matter what may be its figure or density, the term "*Centre of Gravity*" is applied.

[If an immovable straight line, $a b$, Fig. 123, be supported at its centre and loaded at both ends with equal weights, the whole will be in equilibrium, in whatever direction the line be turned round the point at which the central force acts, whether the line be in the position $a b$, or in the position $a' b'$. Let us assume that the two points, a and b , are two heavy molecules, connected by the straight rigid rod, $a b$, supposed devoid of weight, then it is clear that equilibrium must occur if only the point c , be supported, whatever be the position of the line, $a b$. The point, c , would be nothing more than the centre of gravity of the body consisting of the two molecules. We may regard the actions of the forces of gravity of the two molecules combined at the centre of gravity, without on that account the equilibrium being disturbed.—*Professor Müller's Physics and Meteorology, Lecture III.*]

Fig. 123.

A line which connects the centre of gravity with the centre of the earth (or, what is the same thing, a line drawn from the centre of gravity perpendicularly drawn downward) is called the "*line of direction*." If a solid be suffered to fall, its centre of gravity moves along the line of direction until it reaches the ground.

In our reasonings in relation to solids, we may regard them as if all their material particles were concentrated in one point—that point being the centre of gravity—this being the point of application of the earth's attraction. It follows, therefore, that if a body have freedom of motion, it cannot be brought into a position of permanent equilibrium until the centre of gravity is at the lowest place.

To satisfy this condition, sometimes effects which are apparently contradictory will ensue. Thus, the cylinder, m , Fig. 124, so constructed, by being weighed on one side as to have its centre of gravity at the point, g , while its geometrical centre is at c , will roll up an inclined plane, $A B$, continuing its motion until, as shown at m' , where the centre of gravity, g' , is in the lowest position.

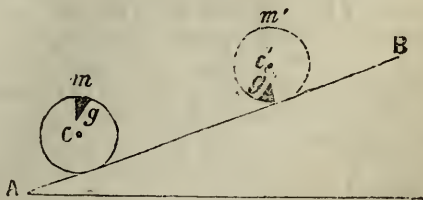


Fig. 124.

A prop which supports the centre of gravity of a body supports the whole body. There are three different positions in which this support may be given :

1st. The prop may be applied directly to the centre itself.

2nd. The point of support may have the centre immediately below it.

3rd. The point of support may have the centre immediately above it.

In the first case, when the point of support is directly applied to the centre of gravity itself, the body, whatever its figure may be, will remain at rest in any position—as is the case in a common wheel, the centre of gravity of which is in the centre of its figure, and this being supported upon the axle, the wheel rests indifferently in any position.

Let $b a d$, Fig. 125, be a brass semicircle, weighted at the parts $b d$, to such an extent that the centre of gravity falls upon the line connecting b and d . To a fasten a light arm, $a c$, long enough to reach to that line, and on this arm, as shown by the figure, the whole body may be balanced.

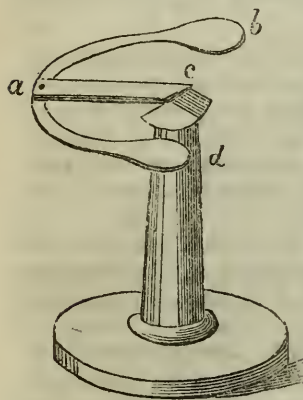


Fig. 125.

2nd. The point of support may be above the centre of gravity. In this case, if the body have freedom of motion, it will not rest in equilibrium until its centre of gravity has descended to the lowest position possible, or until it is perpendicularly beneath the point of suspension. Thus, let there be a circular plate, $E c$, Fig. 126, the centre of gravity of which is at c , and let it be suspended at the point, E , having freedom of motion on that point. Whatever position we may give it to the right or left, as shown by the dotted lines, it at once moves, and is only at rest when E and c are in the same perpendicular line.

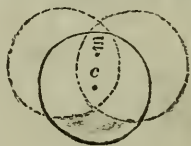


Fig. 126.

In the same manner, if a ball be suspended to a point by a thread, whatever position may be given it, there is but one in which it will remain at rest, and that is when its centre of gravity is immediately beneath the point of suspension, and the thread in a vertical line.

3rd. The point of support may be beneath the centre of gravity. In this case, also, the body will be in equilibrium and at rest; but the nature of its equilibrium differs essentially from that of the foregoing case, as we shall presently see. A sphere upon a horizontal plane affords a case in point; and, as its centre of gravity is also its centre of figure, it will be at rest, no matter what may be the particular point of its surface to which the support is applied.

Upon the principle that if a body be suspended freely, and a perpendicular be drawn from the point of suspension, it will pass through the centre of gravity, we are often enabled to determine the position of that centre experimentally. Thus, let the plane body, $A B C$, Fig. 127, be supported by a thread attached to the point, A , and to the same point let there be attached a plumb line: this line, because it is perpendicular, will pass through the centre of gravity; let the line, $A m$, against which the plumb-line hangs, be marked upon the body. Next, let it be suspended, in like manner, by another point, B , to which the plumb-line is also attached; the direction, $B m'$, of the plumb-line will, in this case, intersect its direction in the former case at some point, such as G . This will be the centre of gravity.

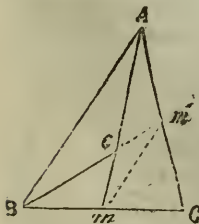


Fig. 127.

[To find the centre of gravity of a polygon, the figure must be divided into triangles, as shown in Fig. 128, and then the centre of gravity of each triangle must be found. As soon as this is done, you have only to find the resultant of the forces acting upon the centres of gravity of the triangles; and this will give the centre of gravity of the whole.

If it is required to find the centre of gravity of a triangular pyramid, it will be necessary to draw lines from the angle, a and b , Fig. 129, towards the centres of gravity, e and e' of the opposite triangles. Where these two lines cut each other at e'' , is the centre of gravity.

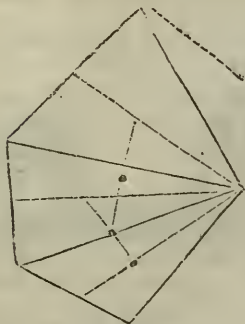


Fig. 128.

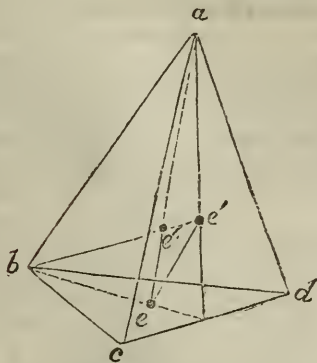


Fig. 129.



Fig. 130.

The centre of gravity of a cone, Fig. 130, with a circular base, lies on the straight line which passes from the apex, a , to the centre of the base, b , and its distance from the central point, b , of the base is $\frac{1}{4}$ of the whole line.

The centre of gravity of a straight line is *exactly* in the middle.—W. T. K.]

When the centre of gravity is *above* the point of suspension, there is produced a pressure upon that point. When the centre of gravity is *beneath* the point of suspension, there is produced a pull upon that point.

The stability of bodies is intimately connected with the position of their centre of gravity. A body may be in a condition; 1st, of indifferent; 2nd, of stable; 3rd, of instable equilibrium.

Indifferent equilibrium ensues when a body is supported upon its centre of gravity; for then it is immaterial what position is given to it—it remains in all at rest.

Stable equilibrium ensues when the point of support is *above* the centre of gravity. If the body be disturbed from this situation, it oscillates for a time, and finally returns to its original position.

Instable equilibrium is exhibited when the point of support is *beneath* the centre of gravity. The body being moveable, in this instance, it revolves upon its point of support, and turns into such a position that its centre of gravity comes immediately beneath that point.

In the theory of the balance, hereafter to be described, these facts are of the greatest importance.

When bodies are supported upon a basis, their stability depends on the position of their line of direction. The line of direction has already been defined to be a line drawn from the centre of gravity perpendicularly downward.

If the line of direction falls within the basis of support, the body remains supported.

If the line of direction falls outside the basis of support, the body overturns.

Thus, let there be a block of wood or metal, Fig. 131, of which c is the centre of gravity, $c d$ the line of direction, and let it be supported on its lower face, $a b$; so long as the line of direction falls within this basis, the block remains in equilibrio.

Again; let there be another block, Fig. 132, of which c is the centre of gravity and $c d$ the line of direction. Inasmuch as this falls outside of the basis, $a b$, the body overturns.

A ball upon a horizontal plane has its line of direction within its point of support; it therefore rests indifferently in any position in which it may be laid. But a ball upon an inclined plane has its line of direction outside its point of support, and therefore it falls continually.

From similar considerations we understand the nature of the difficulty of poising a needle upon its point. The centre of gravity is above the point of support, and it is almost impossible to adjust things so that the line of direction will fall within the basis. The slightest inclination instantly causes it to overturn.

When the centre of gravity is very low, or near the basis, there is more difficulty in throwing the line of direction outside the basis than when it is high. For this reason

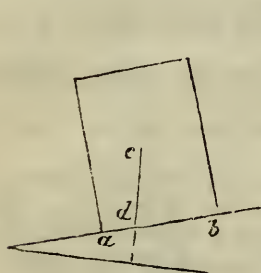


Fig. 131.

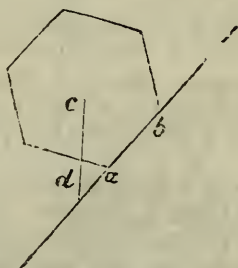


Fig. 132.

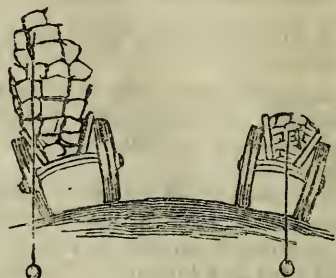


Fig. 133.

carriages, which are loaded very high, or have much weight on the top, are more easily overturned than those the load of which is low, and the weight arranged beneath, as is shown in Fig. 133.

The stability of a body is greater according as its weight is greater, its centre of gravity lower, and its basis wider.

The principles here laid down apply to the case of the flotation of bodies. When an irregular-shaped solid mass is placed on the surface of a fluid, it arranges itself in a certain position, to which it will always return if it be purposely overset. In many such solids another position may be found, in which they will float in the liquid; but the slightest touch overturns them. Bodies, therefore, may exhibit either *stable* or *unstable* flotation. A long cylinder floating on one end is an instance of the latter case, but if floating with its axis parallel to the surface of the liquid, of the former.

These phenomena depend on the relative positions of the centre of gravity of the floating solid, and that of the portion of liquid which it displaces. The former retains an invariable position as respects the solid mass, but the latter shifts in the liquid as the solid changes its place.

Equilibrium takes place when the centre of gravity of the floating body and that of the portion of liquid displaced are in the same line of direction. If of the two the former is *undermost*, stable equilibrium ensues, but if it is *above* the centre of gravity of the displaced liquid, unstable equilibrium takes place. To this, however, there is an exception—it arises when the body floats on its largest surface.

There are two forces involved in the determination of the position of flotation: 1st, the gravity of the body downward; 2nd, the upward pressure of the liquid. The former is to be referred to the centre of gravity of the body itself, and the latter takes effect on the centre of gravity of the displaced liquid. If these two centres are in the same vertical line, they counteract each other; but in any other position a movement of rotation must ensue. The solid, therefore, turns over, and finally comes into such a position as satisfies the conditions of equilibrium.

On these principles a cube will float on any one of its faces, and a sphere in any position whatever; but if the sphere be not of uniform density, one part of it being heavier than the rest, motion takes place until the heaviest part is lowest. A long cylinder floating on its end is unstable, but when it floats lengthwise, stable. It is obvious that these principles are of great importance in ship-building, and the loading and ballasting of ships.

CHAPTER XXV.

THE PENDULUM.

Simple and Physical Pendulums.—Nature of Oscillatory Motion.—Centre of Oscillation.—Laws of Pendulums.—Cycloidal Vibrations.—The Seconds' Pendulum.—Measures of Time, Space, and Gravity.—Compensation Pendulums.

A solid body suspended upon a point with its centre of gravity below, so that it can oscillate under the influence of gravity, is called a pendulum.

A simple pendulum is imagined to consist of an imponderable line, having freedom of motion at one end, and at the other a point possessing weight.

A physical pendulum consists of a heavy metallic ball, suspended by a thread or slender wire.

The position of rest of a pendulum is when its centre of gravity is perpendicularly beneath its point of suspension; its length, therefore, is in the line of direction. If it be removed from this position, it returns to it again after making several oscillations backward and forward. Its descending motions are due to the gravitating action of the earth, its ascending due to its own inertia. A pendulum once in motion would vibrate continually were it not for friction on its point of suspension, the rigidity of the thread, if it be supported by one, and the resistance of atmospheric air.

The length of a pendulum is the distance that intervenes between its point of suspension and its centre of oscillation. Its oscillation is the extreme distance through which it passes from the right hand to the left, or from the left to the right. In Fig. 133, a is the point of suspension, b the centre of oscillation; ab the length of the pendulum; cbd or dbc , the oscillation; the angle a' or β , is the angle of elongation; and the time is the period that elapses in making one complete oscillation. Oscillations are said to be isochronous* when they are performed in equal times.

[The motion from c to b is a semi-descending oscillation, from b to d , a semi-ascending oscillation. The amplitude of an oscillation is the magnitude of the arc, ad , expressed in degrees, minutes, and seconds. The time of an oscillation is the time necessary for the pendulum to traverse this arc.]

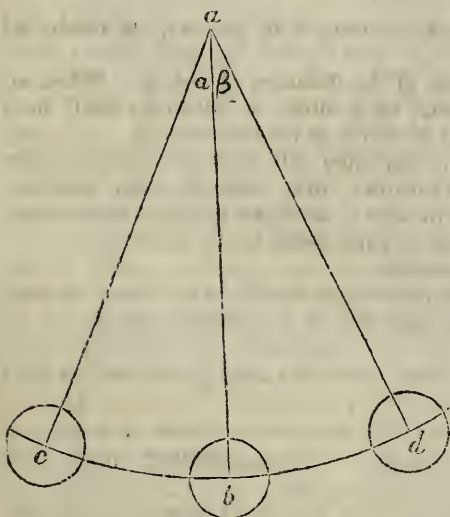


Fig. 134.

Let abc , Fig. 134, be a pendulous body, supported on the point, a , and performing its oscillations upon that point. If we consider the motions of two points, such as b and c , it will appear that under the influence of gravity the point, b , which is nearer to the point of suspension, would perform its oscillations more quickly than the point, c . But inasmuch as in the pendulous body both are supposed to be inflexibly connected together, by reason of the solidity of the mass, both are compelled to perform their oscillations in the same time. The point, b , will, therefore, tend to accelerate the motions of c , and c will tend to retard the motions of b . It follows, therefore, that in every pendulum there is a point the velocity of which, multiplied by the mass of the

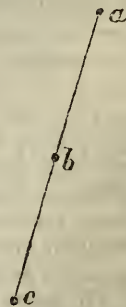


Fig. 135.

* This word is derived from the Greek *isos*, equal, and *chronos*, time. The term signifies equality of time.

pendulum, is equal to the quantity of motion in the pendulum. To this point the name of centre of oscillation is given. In a linear pendulum—that is, a rod of inappreciable thickness—the centre of oscillation is two-thirds the length from the point of suspension. In a right-angled conical mass the centre of oscillation is at the centre of the base.

The centre of oscillation possesses the remarkable property that it is convertible with the centre of suspension—that is to say, if a pendulum vibrates in a given time, when supported on its ordinary centre of suspension, it will vibrate in the same time exactly if it be suspended on its centre of oscillation. Advantage has been taken of this property to determine the lengths of pendulums, with great precision, and thereby the intensity of gravity and the figure of the earth. In these cases a simple bar of metal, of proper length, with knife-edges equidistant from its ends, has been used and adjustment made, until the bar vibrated equally when supported on either knife-edge. The distance between the knife-edges is the length of the pendulum.

Pendulums of equal lengths vibrate in the same place in equal times, provided their angles of elongation do not exceed two or three degrees.

Pendulums of unequal lengths vibrate in unequal times—the shorter more quickly than the longer—the times being to one another as the square roots of the lengths of the pendulums.

If we take a circle, B, Fig. 135, and, causing it to roll along a plane, B D, mark out the path which is described by a point, P, in its circumference; the line so marked is designated a cycloid.*



Fig. 136.

When a pendulum vibrates in a cycloid, it will describe all arcs thereof in equal times; and the time of each oscillation is to the time in which a heavy body would fall through half the

length of the pendulum as the circumference of a circle is to its diameter.

The difference, therefore, between oscillation in cycloidal and circular arcs is, that in the former all oscillations are isochronous, but in the latter they are not; for the larger the circular arc the longer the time of oscillation. And as circular movement is the only one which can be conveniently resorted to in practice, it is necessary to reduce circular to cycloidal oscillations by calculation.

When the length of the pendulum is such that its time of oscillation is equal to one second, it is called a seconds' pendulum. This length differs at different places.

[The following Table shows the length of the seconds' pendulum, in English inches, at several places where it has been tried. It is taken from Mr. Airy's treatise on the "Figure of the Earth," in the "Encyclop. Metrop."

Station.	Latitude	Length of Pendulum	Observers.	Station.	Latitude	Length of Pendulum	Observers.
	o ' "	Inches.			o ' "	Inches.	
Spitzbergen	79 50 N	39·21469	Sabine.	Sandwich Islands.	20 52	39·04690	Freycinet.
Unst	60 45	39·17162	Biot & Kater	Trinidad	10 39	39·01888	Sabine.
Leith Fort	55 59	39·15546	Biot & Kater	St. Thomas	0 25	39·02074	Sabine.
London	51 31	39·13929	Kater.	Bahia	12 59 S	39·02433	Sabine.
Paris	48 50	39·12851	{ Borda, Biot, and Sabine's mean.	Isle of France	20 10	39·04684	{ Freycinet and Duperry.
Bordeaux	44 50	39·11296		Cape of Good Hope	35 55	39·07800	
New York	40 43	39·10120	Sabine.				{ Freycinet and Fallows.
Formentera	38 40	39·09510	Biot (Kater).				

Some allowance must be made for the error in the correction for the density of the air, about ·0018 for each.

* This word is derived from the Greek *kuklos*, a circle, and *eidos*, like. The term signifies a curve generated by the rotation of a circle along a right line.

Under the equator it is shorter than at the poles ; and this evidently arises from the circumstance that the intensity of gravity, as has been already explained, is different at those points ; for the figure of the earth not being a perfect sphere, but an oblate spheroid, its polar axis being shorter than its equatorial, a body at the poles is more powerfully attracted than one at the equator, it being nearer the centre of the earth ; and as the motion of the pendulum arises from gravity, in order to make it oscillate in equal times, it is necessary to have it shorter at the equator than at the pole. The length of the seconds' pendulum in London is 39·13929 inches, at a temperature of 60° Fahrenheit.

For many of the purposes of physical science, the pendulum is an important instrument. It affords us the best measure of time, and is, therefore, used in all stationary timepieces or clocks.

[The manner in which the pendulum regulates a clock may be readily understood by examining the accompanying figure. It is well-known that every clock must have an accelerating force to produce the motion and keep it going. This is supplied by the weight, *c*, which is attached to a line passing round the axis of a toothed wheel, *e*. Now according to the law of falling bodies, the weight is drawn down by its gravity, and pulling down the line at the same time, it turns the axis, and causes the toothed-wheel to revolve. If there was not anything to check the revolution of the wheel, its motion would become accelerated ; but this is prevented by a beam, *a b*, with a tooth at each end, which catches the teeth of the wheel on either side, and as this beam is attached to the pendulum-rod, the motion of the wheel becomes regulated, because the wheel can only move one tooth's distance at each vibration of the pendulum. For example, when the ball of the pendulum, *d*, passes to the right of the weight, *c*, the end of the beam, *a*, which is now represented as being raised, will be depressed, and the other end, *b*, be raised instead. This contrivance is called an *escapement*.—EDITOR.] A clock is a mechanical apparatus for the purpose of registering the numbers of oscillations which a pendulum makes, and at the same time of communicating to the pendulum the amount of motion it is continually losing by friction on its points of support and by resistance of the air. The oscillations are performed in small circular arcs, so that the times are equal.

Whatever affects the length of the pendulum changes the time of its motion. ["The slightest variation in the length of the pendulum, that is, the distance of the weight from the point of suspension, influences the

time of its oscillation ; and this may be readily explained according to the law of the descent of bodies along inclined surfaces. For it is obvious that, since the ball of a short pendulum has to move down a much *steeper* curve than the ball of a long one, it must therefore descend much faster ; so that a very slight diminution in the length of the pendulum, by increasing the steepness of the curve even in a very trifling degree, will diminish the line of its oscillations ; and though this diminution may not be perceptible when two or three, or even twenty or thirty, are counted, it becomes very evident, when a large number are registered, as they are in a clock. In regulating a clock, therefore, we shorten the pendulum (by turning a screw at the bottom, which slightly raises the weight) when we desire it to go faster ; and lengthen it by lettin

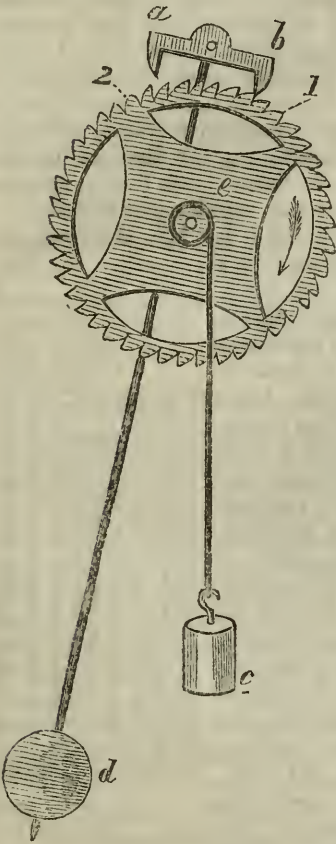


Fig. 137.

down the weight a little when we desire it to go slower. An alteration of no more than $\frac{2}{10}$ ths of an inch will make a difference of five minutes a day in the going of a clock."—*Dr. Carpenter's "Mechanical Philosophy," p. 210.*] It is for this reason that clocks go slower in summer and faster in winter—the changes of temperature altering the length of the pendulum. To compensate this, various contrivances have been resorted to with a view of securing the invariability of the instrument. The nature of these is very well illustrated by the mercurial pendulum, which was invented by Mr. George Graham, a watchmaker, who tested its action in 1721.

Let A B, Fig. 138, be the pendulum-rod; at B it is formed into a kind of rectangle, F C D E, within which is placed a glass jar, G H, containing mercury, and serving as the bulb of the pendulum. When the weather becomes warm, the steel-rod and rectangle elongate, and therefore depress the centre of oscillation. But simultaneously the mercury expands, and this motion takes place necessarily in the upward direction. If the quantity of mercury is properly adjusted the centre of oscillation is carried as far upward by the mercurial expansion as downward by that of the steel. Its actual position remains, therefore, the same; and as the length of the pendulum is the distance between the point of suspension and centre of oscillation, that length remains unchanged. The gridiron pendulum acts on similar principles.

["The gridiron pendulum was contrived by Mr. Harrison, the inventor of the chronometer. It consists of a frame of nine parallel bars of steel and brass, arranged and connected as in the annexed figure. The bars marked *s*, are steel, the four marked *b* are of brass; the centre rod, of steel, is fixed to the cross-bar connecting the two middle brass rods, but slides freely through the two lower bars, and bears the bob, *b*. The remaining rods are fastened to the cross pieces at both ends, and the uppermost cross piece is attached to the axis of suspension. It is easy to see, from the mere inspection of the figure, that the expansion of the steel rods tends to lengthen the pendulum, while that of the brass rods tends to shorten it: consequently, if the two expansions exactly counteract each other, the length of the pendulum will remain unchanged. The relative lengths of the brass and steel bars are determined by the expansion of the two metals, which are found by experiment to be, in general, nearly as 100 to 61. If, then, the lengths of all the five steel bars added together be 100 inches, the sum of the

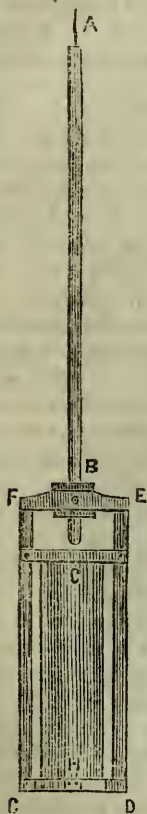


Fig. 138.

lengths of the four brass bars ought to be 61 inches. When the compensation is found on trial not to be perfect, an adjustment is made by shifting one or more of the cross pieces higher on the bars."—*Brande's Dictionary of Science, Literature, and Art, p. 907.*]

The pendulum is also used to determine the force of gravity. The nature of this application has already been pointed out in what has been said respecting oscillations at the equator and the poles. The force of gravity at any place, or the height through which a body will fall in one second, is determined by multiplying the lengths of a seconds' pendulum for that place by the number 4·9348.

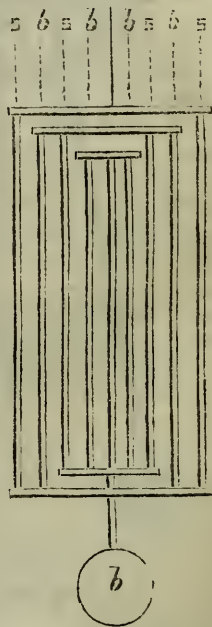


Fig. 139.

SYSTEM OF ELOCUTION.

(Continued from page 228.)

Position of the Feet and lower Limbs.—The parts of the human figure which are brought into action, in gesture, cannot, in truth, be considered separate; for every muscle, over which men can exercise voluntary action, contributes, in some measure, to the perfection of gesture. For convenience, however, we may enumerate and class the most distinguished parts of the body, which effect the principal gestures. These are: 1. The HEAD. 2. The SHOULDERS. 3. The TRUNK. 4. The ARMS. 5. The HANDS and FINGERS. 6. The LOWER LIMBS and KNEES. 7. The FEET.

I shall begin, as it were, with the foundation of the building, and shall first consider the positions and motions of the feet and lower limbs; since without the stability and ease of these, neither grace nor dignity can consist in the standing figure.

As the object of the orator is to persuade, and as prejudice against his person or manners may greatly impede him, he must recommend himself by every attention to his external deportment which may be deemed correct and proper, and guard against every species of inelegance that may prove disadvantageous. He must, therefore, even in his posture as he stands, prefer manly dignity and grace to awkward rusticity and rude strength. Rude strength may suit him who wishes to terrify, or to insult; but this is rarely the purpose of a public speaker. Grace and decorum win favour; and this is the general object. Rude strength stands indeed with stability, but without grace.

The gracefulness of motion in the human form, or perhaps in any other, consists in the facility and security with which it is executed. And the grace of any postures (except such as are manifestly designed for repose), consists in the apparent facility with which they can be varied. Hence, in the standing figure, the posture is graceful when the weight of the body is principally supported by one limb, whilst the other is so placed as to be ready to relieve it promptly, and without effort. And as the limbs

are formed for a mutual share of labour and of honour, so their alternation in posture, and in motion, is agreeable and graceful.

The body must then be supported, if grace be consulted, on either limb, like Apollo, Antinous, and other beautiful and well-executed statues.

The positions of the feet are expressed by the notation annexed, which is to be written *under* the word where the speaker is to assume such position. They are the following:

First Position of the Right Foot.—The upper part of the figure represents the elevation of the position; the lower, the plan.

In this position the right foot (advanced before the left, about the breadth of the foot), forms with the left, an angle of about seventy-five degrees, as may be seen in the plan. The lines which form this angle passing through the length of each foot, meet its vertex under the heel of the left. The principal weight of the body is sustained by the left foot; the right rests lightly, but in its whole length, upon the floor. This fact is shown in the plan by deeply shading the left foot, and lightly shading the right.

Second Position of the Right Foot, (fig. 2).—In this position, the right foot sliding forward about half its length, receives the principal weight of the body, the left being raised, and turning as far inwards towards the right; the ball of the left great toe only lightly touching the floor, to keep the body from tottering. In the plan, the right foot, by which



Fig. 1



Fig. 2.

the weight of the body is principally sustained is *all* shaded, while that part only of the left is shaded which rests upon the floor. The angle formed by lines drawn

through the length of the feet, in this position, is about ninety degrees.

In this position, when the feet are near together, the entire sole of the left foot may lightly touch the floor; but when the feet are separated about their own length, or more, the left should touch only near the great toe; the knee should be bent, and the heel turned inward.

First Position of the Left Foot, (fig. 3).

—This position of the left foot is, in all respects, analogous to the first position of the right. The left foot is advanced, and the body is principally supported by the right. The shading of the plan is similar to that in the first position of the right, and for the same purposes.

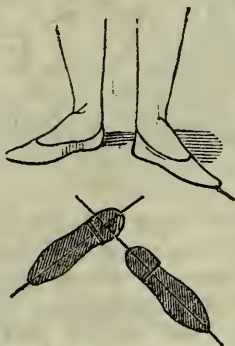


Fig. 3.

The first position of the right foot is the proper reading position, when no gesture is employed; but it should be occasionally alternated with the first position of the left, for the relief of the supporting muscles.

Second Position of the Left Foot, (fig. 4).

—This position of the left foot is, in all respects, analogous to the second position of the right; and, in the figure, it is represented in the same manner, only reversed.



Fig. 4.

Fig. 5 is a better plan of the feet than that annexed to the elevations. In both positions the right foot advances about half its own length, as may be seen by comparing it with the equidistant parallel lines. In the first position of the right foot, the lines *ff*, *ff*, passing through the centre of the feet, make an angle of about seventy-five degrees; and in the second position, the lines *S S* make an angle of about ninety degrees. These angles are nearly bisected by the line *E E*, which

goes to the eye of the person addressed. In the first position, the lines *c*, *f*, *g*, *x*, *b*,* annexed to the dotted prints of both the feet, mark the manner in which they are shifted, without altering their own angle, according as the gesture is directed.

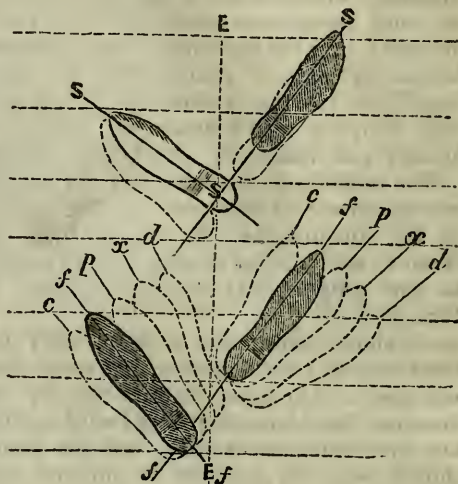


Fig. 5.

In the plan the gesture is supposed to be directed forwards. This figure may be supposed to be reversed for the first and the second position of the left foot.

The first position of either foot, but particularly that of the right (because the more graceful), is the proper reading position. It is also the proper rising position of the orator. But should he stretch forth his arms towards the audience, when he begins to speak, he should take the second position.

Besides the four positions above mentioned, there are two others, which may be called positions in front. The heels are placed nearly together, and the body is supported, alternately, on the right and left foot, whilst the toes of the other lightly touch the floor. The angle formed by the feet, in these positions, is somewhat greater than a right angle. In other respects they are similar to the ordinary positions. The right position in front, noted *R. F.*, is when the body is supported on the left foot. The left position in front, noted *L. F.*, is when the body is

* These are notation letters, which will be explained in their proper place

supported on the right foot. The position in front is used when persons are addressed alternately, on either side, whilst the auditors are in front, as on the stage. It is not graceful, and should not often be used; it is too stiff and formal, like the military figure, and presents the body with too much uniformity and flatness.*

The attitude of the orator should not be like that of the affected dancing-master, which is adapted to springing agility and conceited display. The

orator should adopt such attitudes and positions only as consist with manly simplicity and grace. The toes should be turned, not inwards, like those of the awkward rustic, but moderately outwards; and the limbs should be so disposed as to support the body with ease, and to change with facility. The sustaining foot should be planted firmly; the leg braced, but not contracted; and the knee straightened (contraction suits the spring necessary for the dancer, and bent knees belong to feebleness, or timidity); the other foot and limb should press lightly, and be held relaxed, so as to be ready for immediate change and action, except in very energetic delivery, where both limbs should be braced. The trunk of the body should be well balanced, and sustained erect upon the supporting limb, except in such instances as particularly require its inclination, as veneration, supplication, &c. The orator should *face* his audience. Whatever his position may be, he should present himself, as Quintilian expresses, *æquo pectore*, and never in the fencer's attitude.

In changing the positions of the feet, the motions should be made with the utmost simplicity. All changes of position, except where particular energy requires the speaker to stamp, start back, or advance with marked decision, should

* This appears to be the position condemned by Quintilian: "The swing of those who balance their body to the right side and left, upon the alternate feet, is very ungraceful."

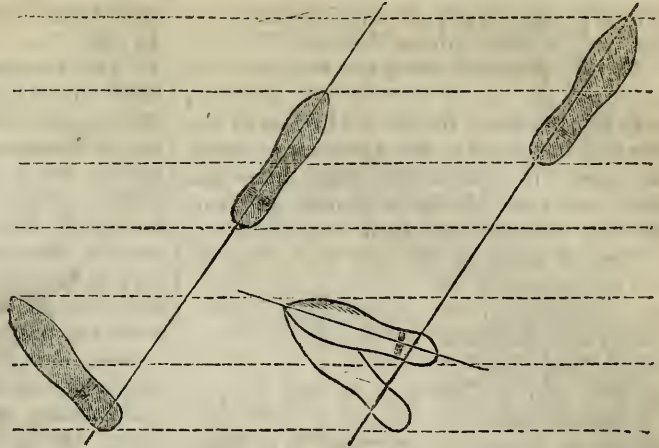


Fig. 6.

be made almost imperceptibly. The changes should not be too frequent; frequent change gives the idea of anxiety and instability.

The several acts resulting from the changes in the positions of the feet, are, *advancing* (noted *a*); *retiring* (*r*); *traversing* (*tr.*); *starting* (*s.* or *st.*); *stamping* (*sp.*), &c.

Changes of position, or steps, are considered to be made only by the foot on which the body is not supported, for that alone is free. Should it be required to move the foot which supports the body, (suppose the left, in the first position of the right, Fig. 1), two motions are necessary; in the first the position must be changed so as to throw the weight of the body on the right foot; then the left may be moved as required.

BOTTLED TEARS. — In some of the mourning assemblies of the Persians, it is the custom for a priest to go about to each person at the height of his grief, with a piece of cotton in his hand, with which he carefully collects the falling tears, and which he then squeezes into a bottle, preserving them with the greatest caution. This practically illustrates that passage in Psalm lvi. 8: "Put thou my tears into thy bottle." Some Persians believe, that in the agony of death, when all medicines have failed, a drop of tears so collected, put into the mouth of a dying man, has been known to revive him; and it is for such use that they are collected.

LESSONS IN FRENCH.

(Continued from page 226.)

Besides these nouns, which are the most conspicuous among those which are used in either gender, there are some more which we will indicate only by the change in their signification, according to gender.

Masculine.	Feminine.
<i>Aide</i> , aide-de-camp.	<i>Aide</i> , assistance.
<i>Aide</i> , a cook assistant, if a man; but it is feminine if a woman.	<i>Aides</i> , tones.
<i>Barde</i> , a poet, among the ancient Celts.	<i>Barde</i> , a thin slice of pork.
<i>Bourgogne</i> , Burgundy wine.	<i>Bourgogne</i> , a province of France.
<i>Cartouche</i> , a sort of ornament in painting, sculpture, &c.	<i>Cartouche</i> , a cartridge.
<i>Champagne</i> , wine.	<i>Champagne</i> , a province of France.
<i>Coche</i> , a public coach, a barge to convey passengers.	<i>Coche</i> , a notch, a sow.
<i>Cornette</i> , a standard-bearer.	<i>Cornette</i> , a cavalry standard, a woman's morning head-dress.
<i>Crêpe</i> , a crape.	<i>Crêpe</i> , a pancake.
<i>Echo</i> , an echo.	<i>Echo</i> , a nymph of that name.
<i>Enseigne</i> , an ensign, a standard-bearer.	<i>Enseigne</i> , a sign of a shop.
<i>Espace</i> , extent between two points or space, speaking of time.	<i>Espace</i> , space, as used by printers.
<i>Forêt</i> , a drill, a piercer.	<i>Forêt</i> , a forest.
<i>Garde</i> , a keeper, a warden.	<i>Garde</i> , watch, hilt, a nurse.
<i>Guide</i> , a guide.	<i>Guide</i> , a rein for driving a horse.
<i>Livre</i> , a book.	<i>Livre</i> , a pound.
<i>Manche</i> , a handle.	<i>Manche</i> , a sleeve, the French channel.
<i>Manœuvre</i> , a labourer.	<i>Manœuvre</i> , a manœuvre of soldiers, the working of a ship, when used figuratively, and meaning <i>action</i> .
<i>Memoire</i> , a bill.	<i>Memoire</i> , memory.
<i>Mode</i> , the mood of a verb.	<i>Mode</i> , fashion.
<i>Office</i> , service, business, prayers.	<i>Office</i> , pantry, larder.
<i>Page</i> , a page at court.	<i>Page</i> , a page in a book.

Of Number in Substantives.—Number, in nouns is the property which they have of denoting either *one* or *several* persons or things.

In the first case they are said to be in the singular: as, *A man*, a table, &c., *un homme*, *une table*, &c.

In the second, they are said to be

in the plural; as, *Men*, tables, *les hommes*, *les tables*.

Proper names, which present to the mind the idea of a single individual or thing, have, generally, no plural; as, *Washington*, *Napoleon*, &c., *London*, *Paris*, &c.; but we may use in the plural, proper names of persons, when we apply them to all persons who resemble those who had them: thus we say, properly, *Nature produces but few such men as Washington, Napoleon*. *La nature ne produit que rarement des Washingtons, des Napoléons*. In such cases proper names become common.

Formation of the Plural in Nouns.—There are nouns whose plural is similar to the singular; they are those which end in the singular with *s, z, x*; so we say, *L'avis*, *les avis*; *le choix*, *les choix*; *le nez*, *les nez*. The advice, the advices; the choice, the choices; the nose, the noses.

Nouns ending in *au, eau, eu, œu, ieu, ou*, form their plural by the addition of an *x*; as, *Le joyau*, *les joyaux*; *l'eau*, *les eaux*; *le jeu*, *les jeux*; *le vœu*, *les vœux*; *l'essieu*, *les essieux*; *le chou*, *les choux*. The jewel, the jewels; the water, the waters; the play, the plays; the vou, the vous; the axle-tree, the axle-trees; the cabbage, the cabbages.

The nouns, the nail, *clou*, hole, *trou*, male-cat, *matou*, cent sou, take an *s* in the plural.

The nouns ending in *al, ail*, change their termination into *aux* in the plural; as, *Animal*, *animaux*; *travail*, *travaux*; *bail*, *baux*. *Animal*, animals; work, works; lease, leases.

But there are some of these terminations which only take an *s* in the plural; as, *ball*, *bal*, *pale*, *pal*, *callosity*, *cal*, *treat*, *régal*, *place*, *local*, *carnival*, *carnaval*, take an *s* in the plural; as, *bals*, *pals*, *cals*, &c.; and attire, *attirail*, capuchin, *camail*, detail, *détail*, fan, *éventail*, scarecrow, *épouvantail*, rudder, *gouvernail*, mall, *mail*, gate, *portail*, seraglio, *sérail*, make in the plural, *attirails*, *camails*, &c.; *trave*, *travail*, a machine to attach horses when shod, makes *travails* in the plural; *sheepfold*, *bercail*, has no plural; *cattle*, *bétail*, also has none; it is in the plural expressed by *bestiaux*, which has no singular. But, as I have already said,

it is necessary to resort to a good dictionary.

Forefather, *aïeul*, heaven, *ciel*, eye, *œil*, make their plurals thus, *aïeux cieux yeux*; but we say, *des ciels* de lit, testers of a bed; *des aïeuls*, grandfather and grandmother; *ciels* d'un tableau, the sky of a picture; ovals, *œils* de bœuf.

All nouns which are not included in any of the preceding classifications, form their plural by the addition of an *s*; as, roads, *chemins*, tables, *tables*, merchants, *marchands*, laws, *lois*, diamonds, *diamants*, accidents, *accidents*, &c.

Orthography of Nouns ending in Ant, Ent.—The nouns ending in *ant*, *ent*, in the singular, must, in all possible cases, keep in the plural the *t* of the singular; it would be absurd otherwise. Let us suppose that a foreigner finds, in writing, the word *enfants*, children; according to the rule, which says that the plural is formed from the singular by the addition of an *s*, if that foreigner should use that word in the singular, he would commit a barbarism; for in removing the *s* from the word *enfants*, it remains *enfan*, which is no French word at all.

We must then write, a diamond, *un diamant*, diamonds, *des diamants*; a present, *un présent*, presents, *des présents*; a glove, *un gant*, gloves, *des gants*.

We insist upon this rule, because a number of grammarians pretend that the *t* may be suppressed in words of more than one syllable, although they do keep it in monosyllables, without any reason whatever for not acting alike in both cases.

The noun *people*, *gens*, the singular of which is very seldom used, is the only one that does not keep the *t* in the plural.

The adjective, *all*, *tous*, follows the same rule. These two exceptions are only the result of *habit*, the greatest tyrant in the construction of language.

Of the Nouns which have no Plural.—They are; First. The names of metals, in their general meaning; as, gold, *l'or*, silver, *l'argent*, iron, *le fer*, copper, *le cuivre*, &c.

Secondly. The nouns which designate ordinary virtues; as, truth, *la foi*, charity *la charité*, sincerity, *la sincérité*.

Thirdly. Verbs in the infinitive used

as nouns, and to which an adjective cannot be joined; as, raising, *le lever*, retiring, *le coucher*, drinking, *le boire*, sleeping, *le dormir*, &c.

But those to which an adjective may be joined, have the two numbers; as, dining, *le dîner*, laughing, *le rire*, &c.

Fourthly. Adjectives used as nouns, and which present to the mind only the idea of a metaphorical object; as, the beautiful, *le beau*, the true, *le vrai*, the useful, *l'utile*, &c.

Fifthly. A series of words, as the following: Absinthium, absinthe; frankincense encens; eucharisity, eucharistie; extreme unction, extrême-onction; esteem, estime; hunger, faim; anger, courroux; glory, gloire; fame, renommée; purple, pourpre; thirst, soif; sleep, sommeil; rest, repos.

Of Foreign Nouns.—Among the nouns of foreign origin, there are only those which usage has made French that take the sign of the plural; the following are the only ones which our best writers use with plural terminations. Des opéras, operas; des impromptus, impromptus; des duos, duetts; des échos, echoes; des accessits, accessits; des agendas, notebooks; des alinéas, new paragraphs; des apartés, words spoken aside; des bravos, bravos; des concertos, witty conceits; des débets, balances of account; des quiproquos, mistakes; des zéros, cyphers; des quolibets, quodlibets; des déficits, deficits; des examens, examinations; des factums, memoirs; des imbroglios, imbroglios; des incognitos, incognitos; des macaronis, macaronis; des magisters, village school-masters; des panoramas, panoramas; des numéros, numbers; des pensums, tasks; des pianos, pianos; des recipissés, receipts; des exéats, passes to leave college; des satisfecits, bills given to children to testify of their good conduct.

All other nouns of foreign origin do not take the mark of the plural.

Of the Formation of the Plural in Proper Names.—When a proper name is used as such, it does not take the sign of the plural; but it changes its termination if used as a common noun.

Of Proper Names representing two or more Individuals in the same Family.—Proper names representing two or more indi-

viduals in the same family remain invariable; as in, My father was acquainted with the two Racine and the two Corneille, Mon père était lié avec les deux Racine et les deux Corneille; Spain is proud of having given birth to the two Sénèque, L'Espagne s'honore d'avoir produit les deux Sénèque. However, we write with the plural termination, *Les Césars, les Gracques, les Horaces, les Scipions, les Stuarts, les Guises, les Condés, les Bourbons, &c.*, either in imitation of the Latins, who used the plural in all cases, or because most of these words are rather used as titles or surnames than names. Some of them are even no longer used to designate individuals personally, but classes of individuals and families.

Of Proper Names which have become Common Names.—I will examine the three tragedies of Œdipe with impartiality, J'examinerai les trois Œdipes avec une égale exactitude; More false than true Elzévir is to be found in most libraries; On trouve plus de faux que de vrais Elzévir dans la plupart des bibliothèques.

In these two examples, *Œdipes* and *Elzévir* are written in the plural, because they signify, in fact, tragedies of which the subject is called *Œdipe*, books which have been printed by Elzévir.

We also say, *Des Raphaëls, des Poussins, &c.*, instead of, *Pictures painted by Raphaël, Poussin, &c.*, because these proper names are so often used that habit has changed them into common names.

Of the Nouns which have no singular.—Several nouns have no singular; as, Ancestors, ancêtres; archives, archives; coat of arms, armoiries; espousals, accordsailles; bushes, broussailles; scissors, ciseaux; manners, mœurs; tears, pleurs; matins, matines; vespers, vèpres; darkness, ténèbres; rubbish, décombres.

Of Nouns of virtues and vices, and of those which represent ideas and sentiments in their abstract meaning.—The nouns alluded to in the title of this chapter, have no plural in their abstract meaning; but when they are used to designate the effects, acts, or results which arise from the existence of any virtue, vice, idea, or sentiment, they follow the general rule; therefore, in the following sentences, kindness is a disposition which cannot be too highly appreciated, *La*

bonté est une qualité qui ne saurait être trop appréciée; Beauty disappears, wit remains, *La beauté* passe, *l'esprit* reste; Man spends his life in looking for happiness; L'homme passe sa vie à chercher *le bonheur*; Charity is agreeable to God and useful to man, *Le charité* est agréable à Dieu et utile à l'homme, the nouns *bonté, beauté, bonheur, and charité*, being used in their abstract meaning, as representing virtues or qualities, but not the consequences of those qualities, have no plural; but in the following, your family overwhelmed me with acts of kindness, *Votre famille m'a comblé de bontés*; There are beauties for all times and countries, *Il y a des beautés de tous les temps et de tous les pays*; With how many trifling instances of good luck is not the worldly man favoured? *De combien de petits bonheurs l'homme du monde n'est-il pas entouré?* This woman is a good Christian; she is very charitable; *Cette femme est bonne Chrétienne; elle fait beaucoup de charités*, the nouns *bontés, beautés, bonheurs, and charités*, no longer express mere qualities or abstract ideas; they represent several acts of kindness, different kinds of beauty, instances of good luck and charity, and, therefore, conveying an idea of individualities, they take the sign of the plural.

Remark. If the above names of virtues, vices, &c., do not take the plural, it is because we consider, as a whole, what the mind cannot divide into several distinct individuals; and besides, those names which the Latins had deified, have become in our language somewhat proper names; and if in poetry, and even in prose, we sometimes, in elevated style, employ the plural instead of the singular, it is in order to restore to these words something of the individuality which they had lost by their transformation.

Of Compound Nouns.—*Of the formation of their plural.*—The compound nouns that have not yet been introduced into the language as making a single word, that is to say, the distinct parts of which are still united by a hyphen, are written in the plural in the most irregular manner, and grammarians are far from agreeing about the rules which ought to regulate them; but there is a general

indication which finds its application in most cases, and may be taken as a sure guide. I mean the nature and particular sense of the words of which they are composed, and which show easily those that require either of the two numbers.

Such is the general principle; the application of which will be rendered easy by the assistance of the following rules:

Of Nouns formed of a Noun and an Adjective.—When a compound noun is formed of a substantive and an adjective, both take the plural; as, A false-key, *une fausse - clé*. Some false - keys, *des fausses clés*. A freemason, *un franc - maçon*. Freemasons, *des francs-maçons*.

Exceptions.—A blank (papers signed in blank), *un blanc - seing*, *des blanc-seings*. A terra plain (places full of earth), *un terre - plein*, *des terre-pleins*. A light-horseman, *un cheval léger*, *des cheval - légers*. A grandmother, *une grand - mère*, *des grand' - mères*. A solemn mass, *une grand' - messe*, *des grand' - messes*.

In the two first examples, the sense does not allow the use of the plural for the words *blanc* and *terre*; in the third, a fantastic usage refuses to the noun the mark of the plural; in fine, in the two last, the adjective remains unchanged, on account of euphony in pronunciation.

When, in compound nouns, there is a word which is never used by itself, this word is considered as an adjective, and takes the plural: as in, Wary-angle, *pie - grièche*, *des pies - grièches*. Were-wolf, *loup-garou*, *des loups-garous*. Gum-gutta, *Gomme - gutte*, *des gommes - guttes*, &c.

In these examples, the words *grièche*, *garou*, and *gutte*, are never used by themselves, and have no sense, unless they are joined to the above nouns.

Of Nouns formed of two Nouns.—When a compound noun is formed of two substantives placed in immediate contact with each other, both take the mark of the plural; as, County town, *un chef-lieu*, *des chefs - lieux*. Wolf - dog, *un chien-loup*, *des chiens-loups*. Cauliflower, *un chou-fleur*, *des choux-fleurs*, &c.

It is evident that these locutions may be turned in this way; the towns which are chief towns, the dogs which are

like wolves, the flowers which turn into cabbages, &c.

Exceptions.—Fig - pecker (birds whose beaks peck figs), *un bec-figues*, *des bec-figues*; painter's maul-stick (sticks to lean the hand upon), *un appui - main*, *des appuis-main*; a hospital for the sick in Paris (places to worship God, or under the patronage of God), *un hôpital-dieu*, *des hôpitals-dieu*; a toothless man (a man who has a breach in his teeth), *un brèche-dents*, *des brèche-dents*.

Of Nouns formed of two Nouns separated by a Preposition.—When a noun is composed of two substantives united by a preposition, the first takes the mark of the plural; as, A rainbow (bows which are in the skies), *un arc-en-ciel*, *des arcs-en-ciel*. A master-piece (works which are chief ones as to their merits), *un chef-d'œuvre*, *des chefs d'œuvre*.

Exceptions.—Nonsense (discourses without sense, where one passes from the cock to the ass), *un coq-à-l'âne*, *des coq-à-l'âne*. Temporary residence (places where one puts only his foot on the ground), *pied à terre*, *des pied à terre*. Face to face (interviews during which a person is alone with another), *tête-à-tête*, *des tête-à-tête*.

In these sentences the meaning of the words *cock*, *foot*, *head*, does not allow them to be placed in the plural.

Of Nouns formed of a Verb, a Preposition, or an Adverb, and a Noun.—When a substantive, in a compound noun, is joined to a verb, a preposition, or an adverb, the substantive alone takes the plural, if there is plurality in the meaning; so we write with an *s* the following words: A counter-blow (blows in the counter-part), *un contre-coup*, *des contre-coups*; herald (runners who run ahead), *avant-coureur*, *des avant coureurs*. The latter end of autumn (seasons which are behind time), *arrière saison*, *les arrière saisons*.

But we write without an *s* in the plural, because there is no plurality in the idea, the following words: Night cap (caps that keep the head tight), *serre-tête*, *des serre tête*; alarm clock (clocks which waken in the morning), *veille-matin*, *des réveille-matin*; counter-poison (remedies against poison), *contre-poison*, *des contre-poison*.

Finally, we write with an *s*, in the

singular as well as in the plural, the following nouns, because there is always plurality in their signification: One or several towels (one or several towels to wipe the hands), *un ou des essuyemains*; one or several snuffers-bearers (one or several instruments to hold the snuffers), *un ou des porte-mouchettes*; one or several toothpicks (one or several sticks to clean one's teeth), *un ou des cure-dents*; one or several key-bearers (one or several men who carry the keys), *un ou des porte-clés*.

Of Nouns formed of two indeclinable words.—When a compound noun is formed only of words which never vary, as verbs, prepositions, adverbs, none of these words take the mark of the plural; as, *Servant-fees, pour-boire, des pour-boire*; a man who never laughs, *un pince-sans-rire, des pince-sans-rire*; a skeleton-key, *un passe-partout, des passe-partout*.

Although these five rules contain what is of general application in the language to compound nouns, it will always be well, when a doubt arises in the mind, to refer to a good dictionary, as the only sure guide in so complicated a matter.

Of the Functions of the Noun in Language.—After having described the substantive in its different phases, it remains now to show how to use it as a part of speech, what place it occupies, and what its functions are in the construction of sentences.

The substantive has three functions in speech; it is either subject, or object, or used in the shape of an apostrophe. It is a subject when it represents that which is spoken of, or performs the action of the verb; when we say, *The horse runs, le cheval court*; the horse does not fly, *le cheval ne vole pas*, the noun *horse* is the subject, because, in the first sentence, we say, that *it runs*, and in the second, that *it does not fly*.

It is to the subject that everything refers in speech; when we say, *A man just and firm* is not moved either by the roaring of an irritated multitude, or the threats of a proud tyrant; if even the world was shaken to the centre, and reduced to ruins, he would be struck but not disturbed by it. *Un homme juste et ferme n'est ébranlé ni par les*

clameurs d'une populace irritée, ni par les menaces d'un fier tyran; quand même le monde brisé s'écroulerait, il en serait frappé, mais non pas ému, the adjectives *just* and *firm* modify the subject *man*, and the rest modifies *a man just and firm*.

The substantive is used in the *apostrophe*, when it designates the thing or person to whom we speak; as, *Kings, be attentive, Rois, soyez attentifs*; *earth, sea, and you, heavens, be sensible to our claims, Terre, mer, et vous, cieux, soyez sensibles à nos plaintes*.

The substantives, *kings, earth, sea, heavens*, are used in the form of an *apostrophe*.

The substantive is an object, when it is under the control of another word; in this case, it restrains the signification of that word. The substantive may be governed by another substantive, an adjective, a verb, or a preposition: The law of God, *la loi de Dieu*; useful to man, *utile à l'homme*; to love one's neighbour, *aimer son prochain*; at one's father's, *chez son père*.

The word which governs is called *governing*; the word which is governed is called *regimen* or *object*.

In French, a substantive cannot be the object of another substantive without the aid of a preposition, which is generally *of, de*, but sometimes, *to, à, for, pour*, and others; as, *The difficulty of the enterprise; la difficulté de l'entreprise*; the attention to one's business, *l'attention à ses affaires*; the taste for pleasure, *le goût pour le plaisir*.

Of two substantives, one governing, the other governed, the one governing *generally* comes first. The beauty of feelings, *la beauté des sentiments*; the violence of passions, *la violence des passions*.

We have used the word *generally*, because sometimes the privilege of *inversion* changes that order.

Sometimes substantives change their nature into that of an adjective; in this phrase of *Bossuet*. All was God, except God himself, *tout était Dieu, excepté Dieu lui-même, God*, in the first part, is an adjective, and a noun in the second.

(To be continued.)

CHEMISTRY.

(Continued from page 222.)

HEAT.

ALL our knowledge of heat is confined to its effects. We experience a sensation on coming near to, or touching other bodies, which we call *heat* or *cold*, according as they have a higher or lower temperature than ourselves. This is the common use of the word. In chemical language, we mean by heat, the unknown cause of the effects produced by it on bodies, and not the sensation. We are as ignorant of the real nature of heat as we are of that of light. It is often called an imponderable agent, as has been before mentioned, because we can find no increase of weight in bodies by heating them, nor any decrease in weight by cooling them. The changes which heat has power to work on matter are wonderful; and as it is one of the most important of chemical agents, we shall be well employed in the study of its phenomena.

Without pausing, therefore, to consider any of the ingenious theories which have been proposed regarding the nature of heat and its relations to matter, we will proceed to consider its sources and effects.

Sources of Heat.—1st. The sun is the great source of heat. His rays alone make the earth inhabitable; without them, this world would be only a barren waste, and its waters would be as solid and unalterable as granite. All the combustible material on or in the earth would not supply the want of the sun for a single day.

2nd. Combustion is another source of heat. Our fires give us warmth, because the combustible part of the fuel takes on a new form of existence, combining chemically with one portion of the atmosphere, and evolving heat. This source of heat, then, is due to a change of state in bodies. The same cause we shall also see, further on, may sometimes be a source of cold, that is, of a diminution of heat. This source of heat is entirely limited by the amount of the substances suffering change, and ceases when the change is complete.

3rd. Friction is a third source of heat. Heat is generated by friction to an indefinite amount, as in the rubbing together of two limbs in a forest, moved by violent

winds, by which it is said that so much heat has been excited, as to set fire to large tracts of timber-land. Savage nations, by rubbing two sticks violently together, are accustomed to produce fire. Large plates of iron have been made to move slowly over each other by water-power, thus producing heat enough to warm extensive buildings. The water beneath which cannon are bored becomes very hot from the friction of the borer against the metal which it cuts. The principal thing to be remarked in reference to this source of heat is, that it seems to be without limit, so long as motion is continued; and that the substances used to produce friction do not necessarily suffer any permanent change of state. The evolution of heat goes on, the substances acted on neither increasing nor diminishing in quantity, while the body retains its chemical properties unaltered.

4th. A fourth source is *Electricity*, and it is probably very closely allied to the second. The spark from the electrical machine, the galvanic current, and the lightning, are alike sources of heat.

We might also mention the warmth of our own bodies, and the whole animal world, as another source of heat; but it seems more than probable that animal heat is only the result of chemical changes going on in the process of respiration, and the other functions of the body, and as such belongs to the second source, already mentioned.

5th. Geology teaches us that the interior of the earth is in a state of intense ignition, amounting at times to fluidity, as is proved by the eruptions of lava from active volcanoes. All the excavations for mines and artesian* wells which have been made have shown, that as we descend the temperature of the earth constantly increases, after we have passed below the influence of the atmosphere. This increase amounts to about 1° of Fahrenheit's thermometer for every 40 or 45 feet of descent. The celebrated well of Grenelle, at Paris (which is an artesian boring), is 1,794 feet deep, and its temperature is 82°.

* Artesian wells are borings made with an auger, usually to a great depth, and are so called from the province of Artois in France, where they were first made.

which is 31° above the mean temperature of Paris; and the well at Mondorf, in the Duchy of Luxemburg, is 2,200 feet deep, and the water rises with a temperature of 95° Fahrenheit. This increase of temperature, if continued at the same rate, would give us boiling water at about two miles from the surface. At ten miles, all solid substances would become intensely red; and at thirty or forty, all known solids would be in a state of fusion. No doubt the central heat of the earth, escaping by insensible degrees to the surface, has had an important influence on its condition.

From whatever source heat may be derived, its effects on matter are the same, and we will first consider one of its most general powers, namely,—

1. EXPANSION.

The effect of Heat in altering the dimensions of Bodies.—Heat has been called the antagonist of attraction: while the latter power acts to bind together the particles of matter, heat tends to separate them. We see about us matter in the different forms of solids, liquids, and gases or vapours. Water presents a familiar instance of a substance known to us in all three of these states; as a solid in ice, a liquid at common temperatures, and an invisible vapour at higher temperatures. The sole cause, so far as we know, of this change of state in water, is variation of temperature.

We have before seen the remarkable power of elasticity in expanding air and other gases. Heat produces expansion in all bodies, even the most firm; and this is so powerful as to set at defiance all attempts to restrain it.

To show the expansion of a solid, a bar of metal is provided with a handle, which, at ordinary temperatures, exactly fits a gauge; on heating this over a spirit-lamp, or by plunging it into hot water, it will be so much swelled (expanded) in all its dimensions, as no longer to enter the gauge. On cooling it with ice, it will again not only enter freely, but with room to spare. The same fact is shown by a small cannon-ball, to which, when cold, a ring with a handle will exactly fit, but on heating the ball in the fire, the ring will no longer encircle it.

The expansion of fluid may be shown by filling the bulb of a large tube, *b* Fig. 54, with coloured fluid to a mark on the stem, *c*. On plunging the bulb into hot water, the fluid is seen to rise rapidly in the stem towards *a*. If it be cooled by a mixture of ice and water, it is seen to sink considerably below the line. If we fill a similar bulb with air, invert it, and plunge the small end under water, we shall then be able to show the expansion of air by heat.

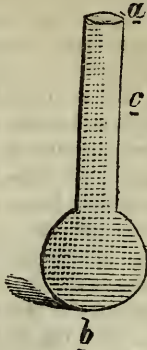


Fig. 54.

When the hand is placed upon the bulb, small bubbles of air will escape from the open end and pass through the water; when the hand is removed the air in the bulb contracts, because the surface of the bulb has become cool, and the fluid will then rise in the stem. The slightest change of temperature will cause this column of fluid to move, as the air expands or contracts. We thus prove experimentally that solids, fluids, and gases, expand by an increase, and contract by a decrease of temperature.

Thermometers.—The law of expansion enable us to construct an instrument by which we can measure changes of temperature with accuracy. Such an instrument is the *thermometer*.* Hot and cold are terms of comparison only, and teach us nothing of the real difference of temperature which bodies may possess. If we place one hand in a vessel of iced water, and the other in moderately warm water, we at once perceive a strong contrast; but if we suddenly plunge both hands into a third vessel of water at the common temperature, our sensations are at once reversed; the third vessel is warm as compared with ice water, and cold as compared with the tepid water. The thermometer, however, enables us with the greatest ease to obtain accurate notions of these comparative temperatures.

This valuable instrument was first constructed by Sanctorio, an Italian philosopher, about A. D. 1590. Sanctorio's in-

* Named from the Greek *thermos*, warmth, and *metron*, measure.

strument was what is now called an *air-thermometer*, because a confined portion of air is employed to show the changes of temperature. The annexed figure shows the arrangements of the parts. A bulb of glass with a long stem is placed with its mouth downwards, in a vessel containing a portion of coloured water. A part of the air is expelled from the ball by expansion, which causes the fluid to rise to a convenient point in the stem, to which is attached a scale of equal parts, with degrees or divisions marked by some arbitrary rule. Thus

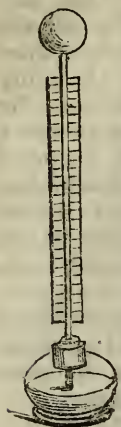


Fig. 55.

arranged, the instrument indicates with great delicacy any change of temperature in the surrounding air. The portion of air confined in the ball, when heated in any degree, expands, and pressing on the column of fluid in the stem drives it down, according to the amount of expansion or the degree of heat; and the reverse results from a decrease of temperature; the confined air then contracting occupies less room, and the fluid rises. The air-thermometer is very delicate, but is too limited in its range to supply the wants of science; it has given place to the—

Mercurial, or Common Thermometer, which is now in every house. This instrument indicates changes of temperature by the expansion of a fluid in a vacuum. It is formed of a small glass tube with a very fine bore (a capillary tube), on one end of which is blown a small ball or bulb to contain the mercury or other fluid with which it is filled. This instrument is made by a process which gives us a fine illustration of several principles already explained, which we will briefly describe.

It would be impossible to pour any fluid (much less mercury) into so small an opening as the fine hair-line of a thermometer-bore. If, however, we cautiously hold the ball of the tube in the flame of a small alcohol-lamp, the heat, expanding the air which it contains, will drive out a portion of it at the open end, which is held under the surface of a small quantity of mercury, and the air will be seen escaping in bubbles through it. Let us hold the

tube as nearly horizontal as possible, and, still keeping its open end under the mercury, withdraw the ball from the heat; as it gradually cools, the contraction of the remaining portion of the air within the ball, aided by the pressure of the air on the surface of the mercury, will cause the fluid to rise rapidly in the tube, and we shall presently see it fall, drop by drop, into the empty ball, until (if the process has been well performed) it is nearly filled. How shall we get rid of the remaining air in the ball and tube? Let us fit a small funnel or cone of paper to the open end of the tube, tie it securely there, and put into it a little mercury, which will quite cover the open end. Now place the ball in the lamp-flame again, and, taking care not to heat the stem, cautiously warm the mercury, until the heavy fluid boils vigorously in the delicate glass ball. The air in the tube is driven out by the vapour of the boiling mercury, and is seen to escape in bubbles through the fluid metal in the paper funnel, which acts as a valve to prevent its return. The whole space is now full of the invisible vapour of this dense metal, and once more withdrawing the ball from the heat, the vapour is condensed, and the pressure of the air on the surface of the mercury in the funnel, instantly forces it into the vacuum beneath, completely filling both ball and stem. The operation of thermometer-making is now completed by once more warming the ball, to expel any remaining portion of the air, and also, if necessary, a part of the mercury in the stem, and at the *same instant* the open end of the tube is sealed by a blow-pipe. On again cooling, the mercury contracts, and leaves a vacuum of the most perfect description. We will explain presently how the thermometer may be fitted with a scale.

Alcohol is also employed to fill thermometers which are to be used for estimating very low temperatures; but mercury is the fluid preferred for all common cases, because of the great uniformity in its rate of expansion.

In the Arctic regions, the temperature, for many weeks together, is below the freezing point of mercury, and there alcohol thermometers are indispensable. Pure alcohol has never been frozen.

Graduation of Thermometers.—To make

the thermometer of any value as an indicator of temperature, we must have a standard of comparison, by which two observers with different instruments, and in different parts of the globe, may compare the results of their observations. We are indebted to Sir Isaac Newton for suggesting the method of graduating thermometers. He knew that ice melted, and water boiled, always at the same temperatures at the level of the sea. By marking the place where the mercury of a thermometer stood, in boiling water, and also in a mixture of snow or ice with water, two fixed and immutable points are obtained, the boiling and freezing of water,* which were found, by repeated trials, to be at the same relative distance in all good instruments. By dividing the space between these points into any number of equal parts, the instrument became complete, and its indications could be compared with those of any other, graduated on the same plan.

Thermometrical Scales.—In this country, Fahrenheit's scale is chiefly employed. It is unfortunate that there should be more than one thermometrical scale in use, because it is inconvenient to translate the terms of any other nation into our own. The scale or division of *Celsius* (a Swedish philosopher) is generally used at present in continental Europe, and is also called the *Centigrade* scale, because it divides the interval between the boiling and freezing of water into one hundred parts. Formerly the French used the graduation of *Réaumur*, which made 80° between boiling and freezing water. Fahrenheit (who was a citizen of Amsterdam) thought that he had found the true zero, or point of greatest possible cold, by means of a mixture of snow and salt. We now know that there is no such thing as an absolute zero† either of heat or cold. Fahrenheit divided his scale from his supposed zero to the

boiling point of water into 212° , which places the freezing of water at 32° , and leaves 180° between that point and the boiling of water. Both Celsius (Centigrade) and Réaumur made the freezing of water the zero of their scales. The degrees of Centigrade are always marked in books C.; of Réaumur R.; and of Fahrenheit F., or Fahr. Therefore $0^\circ\text{C.} = 0^\circ\text{R.} = 32^\circ\text{F.}$; and $100^\circ\text{C.} = 80^\circ\text{R.} = 180^\circ\text{F.}$; and keeping these proportions in mind, it is quite easy to translate the reading of one scale into the other.

The *Self-Registering Thermometer* (often called, also, Six's Thermometer) is a form of the instrument contrived for the pur-

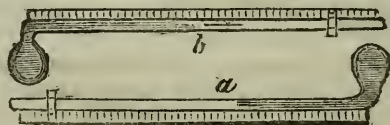


Fig. 56.

pose of ascertaining the extremes of variations which may occur, as, for instance, during the night, or in sounding to great depths in the sea, or measuring the temperature of an artesian boring. It consists of two horizontal thermometers attached to one frame, as in Fig. 56; *b* is a mercurial thermometer, and measures the maximum temperature, by pushing forward, with the expansion of the column, a short piece of steel wire, of such size as to move easily in the bore of the tube; it is left by the mercury at the remotest point reached by the expansion; *a* is a spirit-of-wine thermometer, and measures the minimum temperature. It contains a short cylinder of porcelain, shown in the figure, which retires with the alcohol on the contraction of the column of fluid, but does not advance on its expansion. To use the instrument, it is necessary before every observation to incline it, and with a slight jar bring the cylinder of porcelain in *a* to the surface of the fluid.

The *Differential Thermometer* is a form of air-thermometer, with two bulbs on one tube, bent twice at right angles, and supported as shown in the figure; a little sulphuric acid, water, or other fluid, partly fills the stem only (shown by the cross lines in the figure.) When the bulbs of this instrument are heated or cooled alike, no change is seen in the position of the

* We shall see hereafter that, although the melting and freezing of water take place at the same temperature, under favourable circumstances, yet that it is the *melting* of ice, and not the *freezing* of water, which gives invariably the constant temperature of 32° —the freezing point being liable to some variation.—*Editor*.

† The word *zero* is from the Italian, and signifies "*nothing*," and was applied to the thermometer in allusion to the supposed absence of all heat.—*Editor*.

column, but the instant any inequality of temperature exists between them, as from bringing the hand near one of them, the column of fluid moves rapidly over the

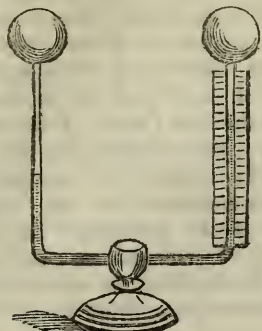


Fig. 57.

scale. A modification of this instrument, of great delicacy, was contrived by Dr. Howard, of Baltimore, in which ether was used, the bulbs being vacuous of air. It is called a differential thermometer, because it notes only differences of temperature, and not actual temperature.

Pyrometers.—All common thermometers are limited to comparatively low temperatures. Mercury boils at about 660° , above which we can judge of temperatures only by the expansion of solids. We have thermometers made with gases or vapours, and with fluids, and pyrometers made with solids.

A *Pyrometer** is an instrument for measuring *high* temperatures. The only instrument of this sort which we need mention, as it is the only one susceptible of accuracy, is Daniell's Register Pyrometer. It consists of a hollow case of black lead, or plumbago, into which is dropped a bar of metal (platinum is preferable), secured to its place by a strap of platinum and a wedge of porcelain. The whole is then heated, as, for instance, by placing it in a pot of molten silver, whose temperature we wish to ascertain. The metal bar expands much more than the case of blacklead, and being confined from moving in any but an upward direction,

drives forward the arm of a lever, as shown in Fig. 58, over a graduated arc, on which we read the degrees of Fahrenheit's scale; (this graduation has been determined beforehand with great care.) This instrument gives very accurate results; by it the melting point of cast iron has been found to be $2,786^{\circ}$ F., and of silver $1,860^{\circ}$ F. The highest heat of a good wind-furnace, is $3,300^{\circ}$ F.

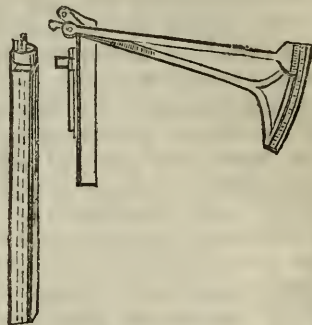


Fig. 58.

Having, to a sufficient extent, become acquainted with instruments for measuring temperature, and with the principles of their construction, we can now proceed intelligently with our main subject.

Expansion of Solids and Liquids.—1. Different solids expand differently with equal increase of temperature. 2. The same solid expands equally for every equal addition of heat below 212° . Between the freezing and boiling of water, 350 cubic inches of lead become 351; 800 of iron become 801; and 1,000 of glass become 1,001. Each solid, in fact, has a rate of expansion peculiar to itself. The same is true of liquids. 1,000 parts of water between 32° and 212° , expand to 1,046 parts; and 1,000 parts of quicksilver become 1,080 parts. The expansions are gradual, both in solids and liquids, and on withdrawing the heat, they return with equal regularity to their former dimensions. Above 212° , the expansion of both solids and liquids becomes irregular and increases.

The unequal expansion of solids is well shown by joining firmly, by rivets, two bars, one of iron and one of brass, as in Fig. 59. When they are heated, the brass expanding most, will cause the compound bar to bend, as shown in Fig. 60. If they are cooled by ice, the brass contracting

* From the Greek, *pur*, fire, and *metron*, measure. A very convenient form of pyrometer for illustration, is made by all instrument-makers, which shows the expansion of a metallic bar, heated by a spirit-lamp, moving an index like a clock-pointer.—Editor

most, will bend the united metals in an opposite direction.

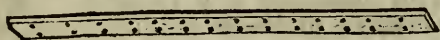


Fig. 59.

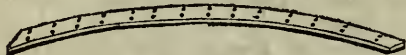


Fig. 60.

The *Compensation Pendulum* gives a beautiful application of the law of unequal expansion to regulating the rate of time-pieces. The length of the pendulum is altered by variations of temperature, and of course the rate of the clock is disturbed. A perfect compensation for this error is obtained by the use of a compound pendulum of brass and iron, or other two metals, arranged as is shown in Fig. 61, in

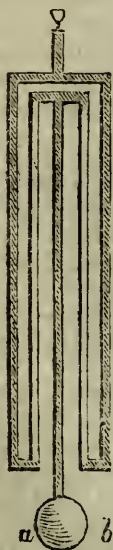


Fig. 61.

such a manner that the expansion of one metal downwards will exactly counteract that of the other metal upwards; thus keeping the ball of the pendulum at a uniform distance from the point of suspension. The shaded bars represent the iron, and the light ones the brass. The same object is accomplished by using mercury, as shown in Fig. 62, contained in a glass or steel vessel at the end of the pendulum-rod. The expansion which length-



Fig. 62.

ens the rod also increases the volume of the mercury; this increase of bulk in the mercury raises the centre of gravity to an exactly compensating amount, and the clock remains unaltered in rate. Watches and chronometers are regulated by a like beautiful contrivance. The balance-wheel,

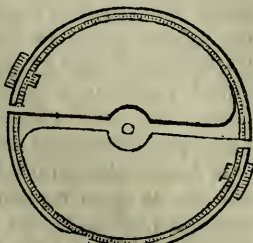


Fig. 63.

Fig. 63, on whose uniform motion the regularity of the watch or chronometer depends, is liable to a change of dimensions from heat or cold. If made smaller, it will move faster, and if larger, slower. To avoid this error, the outside of the wheel is made of brass, the inside of steel, and cut at two opposite points; one end of each part is screwed to the arm, and the loose ends of the rim, being united by a screw, are drawn in or thrown out by the changes of temperature, in precise proportion to the amount of change; thus perfectly adapting the revolution of the wheel to the force of the spring. The principle of this wheel will be seen in the compound bars.

SKETCH OF THE LIFE OF WILLIAM OF WAYNFLETE.

THE career of a good man in troubled times, is to contemplate, as an oasis in a burning desert, or a bright sunbeam in the midst of a tempest; when all around is disturbed, there is serenity with him; when all else savours of this world, his life seems to open a glimpse of Heaven. Such was the course of William Waynflete, Bishop of Winchester, and for a few years Lord Chancellor of England. His lot was cast in days as evil as England ever saw; war devastated the land, and as each party had the ascendancy, the friends of the other became a prey to the sword; yet his way was that of peace, and he left behind him lasting testimonies to his exertions for the benefit of his countrymen.

The date of his birth and place of his education cannot be ascertained with certainty; it seems probable that he studied at New College, Oxford. He was undoubtedly of gentle birth, and when he received clerical ordination, he followed a custom prescribed at the time, of changing his patronymic (which was Barbor, or Patten), for a name taken from the place of his birth, Waynflete, in Lincolnshire. It may be amusing to some of our young readers, who have a mournful memory of the difficulties of the spelling-book, to know that the orthography of this name is, in documents of that period, varied in no less than seventeen different

ways. The one adopted here is the one used by the bishop himself,—and that, his first recorded act, is the persuading Leilont, the author of a new Latin Grammar, to publish it. This was the first grammar taught at Eton.

He was ordained deacon in 1420, by Fleming, Bishop of Lincoln; and presbyter, six years later. In the following year he was appointed Master of Winchester Grammar School, which had been founded by the late Bishop William of Wykeham. The position was even then one of some eminence; but let those who have seen the well-furnished houses and tables, the carriages, servants, and conveniences of life, now possessed by the master of a public school, cast their eyes back a few centuries, and picture to themselves the learned master of the fifteenth century, allowed twelve pence a-week for commons, when wheat was cheap, and not more than fourteen pence in the dearest times; also, every Christmas, about eight yards of cloth, about 1s. 9d. per yard, not white, black, russet, or green, which he was to have made into a decent gown, reaching to his heels; 3s. 4d. for a fur trimming to the gown; and £10 per annum for teaching. Such was the provision for William Waynflete, and with it he performed his duties so well as to attract the notice of Cardinal Beaufort, Wykeham's successor in the see of Winchester, great uncle to Henry VI. By this "proud prelate," he was presented to the Mastership and Chantry of the Hospital for Lepers, dedicated to St. Mary Magdalen, within a mile of Winchester; and by him and Bekyngton (an early friend of Waynflete), he was named to the king, whose thoughts were turned towards the foundation of Eton School and College. After a personal examination of Winchester College in 1440, Henry resolved to transplant him to Eton, and thither he removed in 1442, before the buildings were completed. After exercising the office of master for three years, he was elevated to the provostship, and on the death of Cardinal Beaufort, named as his successor. The king had anxiously desired that he might be appointed to the see; was present at his inthronization, and often was with him during the next five years, giving the fullest testi-

mony to the estimation in which he held him by appointing him executor of the testamentary provisions which he made to insure the completion of the colleges he had founded (Eton and King's College, Cambridge.)

Humble in feeling, and moderate in wants, the new bishop resolved at once that the surplus of his revenue should be dedicated to the advancement of religion and learning, and after providing for the full repair of all buildings belonging to him in the diocese, he proceeded to found the Hall and College of St. Mary Magdalen, in Oxford. The grant for this purpose was obtained within a year of his elevation to the bishopric; and the attention which he bestowed on all the details of arrangement and management, providing at once for the comfort and good order of the inmates, are deserving of great admiration, when we consider the various calls which divided his thoughts, time, and feelings.

For now the storm of civil war threatened to burst over the miserable country, and Waynflete, the firm friend of King Henry, was called to his councils, and even obliged on one or two occasions to depute a visitor in his diocese, owing to the great and pressing affairs concerning the king and realm which prevented his personal attendance.

It was in mediation that his offices were most frequently engaged; the rebellion of Cade was put an end to, chiefly by his wise and moderate advice. When Cade had been driven from the City, he was summoned to a council, by night, in the Tower, where Archbishop Stafford, the Lord Chancellor, had taken refuge. He was of opinion that they might win over, by hopes of pardon, those whom they could not subdue by force of arms. In the morning the two prelates crossed the water, and in the church of St. Margaret held a conference with Cade and his principal officers, and a pardon under the great seal proved so welcome, that dispersion began the same night. The prelates met the king at Canterbury with the good tidings, but peace was not yet to return; the enmity of the Yorkists was excited at this time against Waynflete, as appears from a public act performed by him the following year, 1451, in the presence of

two bishops and other witnesses, to make declaration that he had obtained the see canonically, and was ready to obey the laws; and the following day he named a committee of nineteen persons to manage any affair, in which he, or the see should be attacked.

In the same year we find him engaged as a Christian bishop should be, ordering public prayers that the evils of war might be averted. But in the month of November, the deadly preparations were completed; the Duke of York encamped near Dartford, and the king at Blackheath. The two armies were arrayed for battle, but instead of advancing to attack, the Bishops of Winchester and Ely, with two lay lords, issued from the ranks to try the effect of mediation, and so successful were their efforts, that the Duke of York renewed his allegiance, and, for a short period, peace was restored. The birth of the unfortunate Prince Edward, and the illness of the king, perhaps hastened the designs of the Yorkist party; by the former they thought their own claims thrown into the background, and the latter facilitated the assumption of power. While the Duke of York acted as the king's Lieutenant, Waynflete subscribed several acts of the council, but when the parties divided, he remained true to his allegiance.

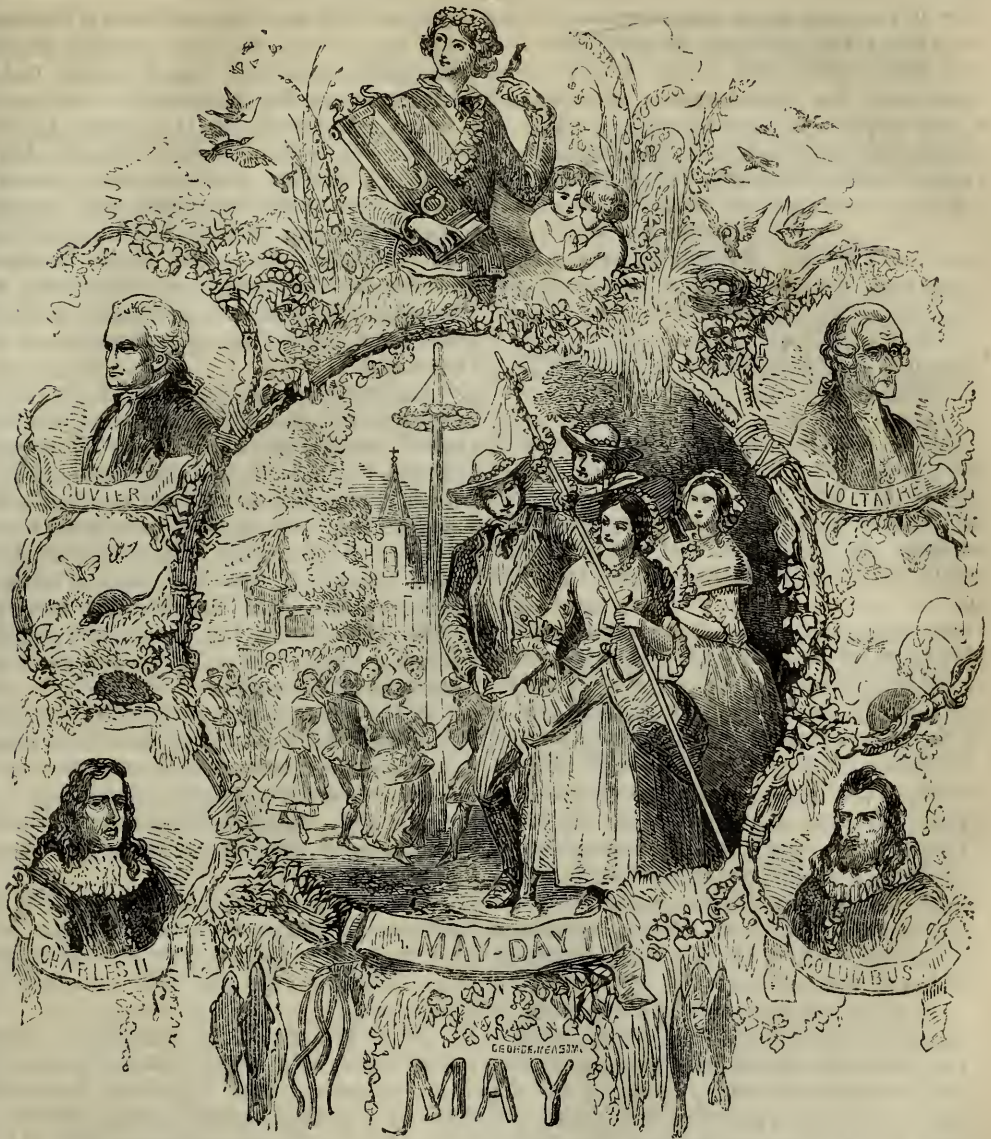
In 1456, the court was held in the Priory, at Coventry, and there, in the presence of the king, the Duke of York, and many lords, spiritual and temporal, Waynflete received the chancellor's seals,—two large ones of gold, and one of silver; he signalled his accession to office by setting the silver one to a pardon, and then closed them all in a bag with his own signet. During the four years he was chancellor, wars, and rumours of wars, went through the land; yet we hear of him retiring with the monarch who honoured him with friendship, to offer up prayers for the common weal. Some consolation in present evil may also have been derived from the progress of their foundations, intended as the abodes of peace and virtue. Several grants and additions to both colleges are dated at this period.

Waynflete had been invested with his high dignity in a consecrated Priory; he resigned it in the tented field:—"On Monday, 7th July, about five in the after-

noon, he delivered the silver seal to the king, in his tent, then standing in Hardinstonfield, near the Abbey de la Pré, by the town of Northampton, in the presence of the Bishops of Hereford and of Durham, keeper of the Privy Seal, and of Master Thomas Marning, the king's secretary, and two esquires; and, then, by royal command, it was placed in a certain chest in the tent, of which he immediately delivered the keys to the king." His resignation at this time exposed him to some suspicion of disloyalty, but not in the mind of the king, who retained towards him the warmest feelings to the last.

Bishop Longland relates that he was in great "indignation with Prince Edward, and fled for fear of him into secret corners, but, at last, was restored to his goods and the king's favour." An attack was made on his character when Edward IV. was established in power, which was tried, but it signally failed, and in 1466, a deed in his favour was executed, the king specifying that he had regard to his "manifest good deserts." He was among the lords spiritual who swore fealty to the infant Prince, afterwards Edward V., and as prelate of the Order of the Garter, performed the service at a solemn installation in 1476. During all these years he was employed also in watching over his favourite institution at Oxford (it was not until 1480 that the first President, D. R. Mayhew, was appointed), and in establishing a Grammar School at Waynflete, the place of his birth. In the same year as his usurpation of the crown, Richard III. came to Oxford, and visited Magdalen College, the founder being present. During the prevalence of the plague in 1483, he provided a place for the retirement of the scholars as a security from the pestilence. His life was prolonged till he saw the College produce good and eminent scholars, and till he saw the restoration of the Lancastrian branch of the royal family, in the person of Henry VII., but not to witness the union between that king and Elizabeth of York. He prepared for his departure out of this life with the calmness which became a Christian, and expired at his house at Southampton, after a long delay, on the 11th of August, 1486.

His deeds require no comment.



MAY, sweet May! again is come,
 May that frees the land from gloom;
 Children, children, up, and see
 All her stores of jollity!
 On the laughing hedgerow's side
 She hath spread her treasures wide;
 She is in the greenwood shade,
 Where the nightingale hath made
 Every branch and every tree
 Ring with her sweet melody:
 Hill and dale are May's own treasures;
 Youths rejoice! In sportive measures,

Sing ye, join the chorus gay,
 Hail this merry, merry May!

T. ROSCOE.

'Tis morning, a bright and joyous one,

and floods of golden light are penetrating the woodland dells, where fragrant flowers are bathed in dew,—sweet May dew! The banks of the gently murmuring stream that winds through these flowery meads, afford us a pleasant seat from whence to survey the beauteous scene around. The bright green fields and meadows spangled with cowslips and daisies, contrast with the lights and shadows on the streamlet's bosom, and the snowy hedges of white-thorn, or May, which divide us from the dusty road; while

"In the lone copse or shadowy dale,
Wild cluster'd knots of hare-bells blow,
And droops the lily of the vale."

Beneath the outstretched umbrageous
arms of yonder group of trees, a choir of
feathered songsters welcome Creation's
smile; while above us, float the painted
clouds,

"—hung in air
To greet our raptured view;"

and from behind the roof of the humble
cot in mid distance,

"—the slim ash and massy sycamore,
Blending their diverse foliage with the green
Of ivy, flourishing and thick."

Nature appears decked in her gayest
attire, for the laburnum, lilac, and honeysuckle are blended with the red flowering
May, the barberry, and the rhododendrons. The air is laden with the most
exquisite perfumes, and we hear the song
of

"The skylark overhead; the speckled thrush
Who now has taken with delight his seat
Upon the slender larch, the day to greet;
The starling, chattering to her callow young;
And that monotonous lay, which seems to fleet
Like echo through the air, the cuckoo's song,
Is heard at times far off the leafy woods among."

May, the third month in the year of
Romulus, was the fifth in that of Numa
Pompilius, a position in the calendar it
has since retained. Romulus assigned
thirty-one days to this month, Numa
reduced the number to thirty, and Julius
Cæsar restored it to the original length,
which it now retains.

There is a doubt about the origin of the
name of this month; because, although
the Romans offered sacrifices to Maia,*
the mother of Mercury, upon the first day
of this month, yet it appears pretty evident
that the name was fixed long before
the time of Romulus. Some antiquaries
assert that Romulus named the month in
honour of his senate, who were distinguished
by the name of *Majores*, or the
greater counsel; but this account has
been much ridiculed by others. One
thing appears to be generally admitted—
that the ancients considered this month
under the protection of, and therefore

dedicated it to, Apollo; and as this was
the period wherein they made several
expiations, marriage was forbidden to be
celebrated during this month.

The synonymes of the month are as
follows: in Latin, *Maius*; French, *Mai*;
Italian, *Maggio*; Portuguese, *Maio*;
Saxon, *Tri-milchi*; and ancient Cornish,
Me. Verstegan says that "the pleasant
month of May they (the Anglo-Saxons)
termed by the name of *Tri-milchi*, or
Trimilki, because in that moneth they
began to milke their kine three times in
the day."

Ancient painters represented May as a
young man with a beautiful face, clad in
green, embroidered with various bright
flowers, and a garland of white and damask
roses upon his head. In one hand he
held a lute, and on the forefinger of the
other a nightingale, allegorical of the
"eve song," of this bird, which is first
warbled during the month. The sign of
Gemini, the Twins, also accompanied him,
alluding to the sun entering that sign on
the 20th of the month.

Poets have apostrophised May as the
harbinger of rural joys and festivities.
Thomson has written in her praise and
Spenser has described her beauties in his
quaint style; while a host of others have
welcomed her arrival in dignified verse
and prose.

There is not a day in the year that is
devoid of historic interest, and May has
her fair share of the number, of which
the following are the most worthy of
mention.

THE FIRST DAY, commonly called
MAY DAY, is a very remarkable one in
our calendar, and therefore we shall
devote a greater space to its consideration
than to the less important days of the
month.

It is dedicated to *St. Philip and St. James the Less*. St. Philip was born at
Bethsaida, near Tiberias, and is supposed
to have been the first of our Saviour's
disciples and an apostle; he died at
Hierapolis, in Phrygia. St. James the
Less, who was also called James the
Just, and by the apostle Paul, James,
the Lord's brother, because he was the
son of Joseph, as is supposed by a former
wife, afterwards the husband of the
Virgin Mary, underwent martyrdom in a

* Maia, the brightest of the Pleiades, is said
by mythologists to have been a daughter of
Atlas, the supporter of the world, and Pleione,
a sea-nymph.

tumult in the Temple, about the year sixty-two.

In former times the village lads and lassies, left their homes at break of day,

“On a May-day morning to fetch in May.”

These good old times have long since passed away, and are now only honoured in the remembrance, not the observance. Although hoary Time has seldom patted our head with his whitened hand, yet we have not forgotten the days when we

“———rose up early, to observe
The rite of May,”

and joined in all the festivities of the month, not omitting the May eve song, which was greeted by those who could not join our choir, with loud and boisterous huzzas, and washed down with good, home-made cowslip wine, mature, and nearly as bright as the damsels' eyes that contested for the honour of May Queen on the morrow. We almost wish that the past days were to be recalled, or at least that we could again join in the following characteristic song of the youths who went forth on the “May morning:”

THE MAYER'S CALL.

Come, lads, with your bills,
To the wood we'll away,
We'll gather the boughs,
And we'll celebrate May.
We'll bring our load home,
As we've oft done before,
And leave a green bough,
At each good master's
good neighbour's } door.
pretty maid's
To-morrow when work's done,
I hold it no wrong,
If we go round in ribands,
And sing them a song.
Come lads, bring your bills,
To the wood we'll away,
We'll gather the boughs,
And we'll celebrate May.

After the May was gathered, we bore it home in triumph, with dancing, piping, and singing the characteristic song,

‘May, that is now in its bloom,
All so fragrant and so fair,
When autumn and when winter come,
Shall its useful berries bear.”

Then we had the May-pole, painted with various colours, dressed with garlands and streamers, and surmounted by a large crown; and well do we remember the village fiddler, seated upon a cask,

and scraping away vigorously for the lads and lasses to skip around the May-pole. There were a goodly number of them,

“The young ones footing it away;
The aged cheering their old souls
With recollections and their bowls,”

Those were merry days, long since fled and almost forgotten.

Everyone knows the sports of the chimney-sweepers upon the first of May, and the two following days; but very few are aware that Jack-o'-the-Green originally consisted of a man dressed out with flowers and ribbons, with a long walking-stick, having a wreath of flowers twisted around it. This strange character danced away at the festivities, whisking his stick about his head, and keeping up the spirit of the games; but now the man is hidden under a huge mass of green leaves affixed to a light framework and surmounted by a floral crown.

Gradually all our old customs are becoming obsolete. Time was when “bluff King Hal” and his queen, joined in the May-day games; but now, Lady May, Lady Flora, the morris-dancers, the milk-maids' dance, and hobby-horses, are only known by report; they have given way to the chimney-sweepers with clown and pantaloons.

The May-day festivities are said to have originated with the Romans, who worshipped Flora, and celebrated her festivals by rejoicings and offerings of spring flowers, and the branches of trees in bloom.

The first of May, in the Irish language, is called *La Beal tine*, or the day of Beal's (Baal's) fire, which leads us to conclude that Baal was formerly worshipped in Ireland. A correspondent of “Notes and Queries” writes thus respecting the first of May in Scotland:—“The late Lady Baird, of Ferntower, in Perthshire, told me that, every year at Beltane (or the 1st of May), a number of men and women assembled at an ancient druidical circle of stones on her property, near Crieff. They light a fire in the centre; each person puts a bit of oatake into a shepherd's bonnet; they all sit down and draw blindfold a piece of cake from the bonnet. One piece has been previously blackened, and whoever gets that

piece has to jump through the fire in the centre of the circle and to pay a forfeit. This is, in fact, a part of the ancient worship of Baal, and the person on whom the lot fell was formerly burnt as a sacrifice: now, the passing through the fire represents that, and the payment of the forfeit redeems the victim."

This year *Rogation Sunday* falls upon May-day. It takes its name from the Latin *Rogare*, to beseech or ask: because Mammertius, Bishop of Vienna, appointed the three following days for the offering of supplications with fasting, to be offered up to avert the calamities that had befallen his diocese. This was done in the year 469, and confirmed by the first Council of Orleans.

In 1700, died John Dryden, the eminent poet and translator of Virgil, Juvenal, and Persius.

In 1851, Her Most Gracious Majesty opened the Great Exhibition of all Nations in Hyde Park, London, in state.

THE SECOND DAY, dedicated to *St. Athanasius*, Patriarch of Alexandria, who died A. D. 373. He is celebrated for his opposition to the Arians, and from his name having been affixed to the creed which contains his doctrines, and which was compiled in Latin in the fifth century.

In 1519, Leonardo da Vinci died in the arms of Francis I. at Fontainebleau, aged sixty-seven. As the painter of the "Last Supper," he is well known, and he also deserves to be remembered for his excellent work on painting, "*Trattata della Pittura*."

THE THIRD DAY.—*The Invention of the Cross*.—This is the anniversary of the alleged discovery, by St. Helena, the mother of the Emperor Constantine the Great, of the cross on which our Saviour suffered. As there were three crosses found,* the Empress is said to have had some difficulty to discover which was the true one, until a sick woman being placed upon each, was healed by one, which was, therefore, pronounced to be the one on which our Saviour suffered.

In 1495, Christopher Columbus discovered the island of Jamaica, in the

West Indies, which was taken from the Spaniards by the English on the same day in 1655.

THE FOURTH DAY.—In 1471, the battle of Tewkesbury, Gloucestershire, was fought, and a victory gained by Edward IV. over the Lancastrians. In 1677, died Dr. Isaac Barrow, the eminent mathematician and divine, aged forty-seven.

THE FIFTH DAY, this year is *Ascension Day*, or *Holy Thursday*, which is the anniversary of Christ's ascension, formerly celebrated by processions, which were abolished at the Reformation. The ministers and officers of the various parishes, with those who please, followed by the boys of the parish school bearing peeled willow wands, proceed in procession to the different parish boundaries, which are struck with the white wands, and this is called "beating the bounds."

In 1821, Napoleon Bonaparte died at St. Helena.

THE SIXTH DAY is dedicated to *St. John the Evangelist*, who is said to have been plunged into a cauldron of boiling oil, by order of Domitian; but as he was not harmed he was permitted to live, and was afterwards banished to the desert isle of Patmos, in the Archipelago, where he is supposed to have written the "Apocalypse" or book of "Revelations."

In 1757, was fought the celebrated battle of Prague.

THE SEVENTH DAY.—B. C. 399, Socrates was put to death by poison at Athens; and in 1676, Pietro Giannone, was born at Ischitella, in the province of Capitanata. He is known as the author of works upon jurisprudence and history; he died at Turin, in March, 1748, at the age of seventy-two, after twelve years of imprisonment.

THE EIGHTH DAY.—In 1794, Antoine Laurent Lavoisier, the celebrated chemical philosopher, was guillotined, aged fifty-one years, leaving a widow, who afterwards married the celebrated Count Rumford.

THE NINTH DAY.—In 1805, died Frederick Schiller, the great German dramatist and poet; and in 1849, Sir Robert Wilson died, at seventy-two.

THE TENTH DAY.—In 1727, was born at Paris, Anne Robert Jacques Turgot, a

* For a description of the place where the crosses were found, see "Family Tutor," vol. iii. p. 229.

celebrated statesman in the time of Louis XV., and author of various works on legislation and other subjects.

THE ELEVENTH DAY.—In 1778, William Pitt, Earl of Chatham, died, in his seventieth year; and in 1780, Richard Wilson, the eminent English landscape painter, died in want, at the age of sixty-eight.

THE TWELFTH DAY.—In 1641, the Earl of Strafford, prime minister during part of the reign of Charles I. was beheaded; and in 1791, died Francis Grose, an eminent antiquarian, author of "The Antiquities of England and Wales, Scotland and Ireland."

THE THIRTEENTH DAY, or Old May day.—In 1832, Baron Georges Cuvier, the celebrated naturalist and geologist, died, aged sixty-three.

THE FOURTEENTH DAY.—In 1686, was born, G. D. Fahrenheit, whose name is so intimately connected with the history of thermometers; and in 1820, died Henry Grattan, the eminent Irish orator and statesman.

THE FIFTEENTH DAY this year, is *Whit Sunday*.—It is named Whit or White Sunday, because on this day the catechumens appeared in the ancient church in white garments, and Whitsuntide is most probably a contraction from White Sunday tide or time. The festival of Whitsuntide, or the Day of Pentecost, was established to commemorate the miraculous descent of the Holy Ghost on the Apostles. Antiquarians do not altogether agree respecting the etymology of the name of Whitsuntide, but as our space may be more profitably occupied than in recording their controversies, we shall consider other matters in preference.

In 1664, Cardinal Giulio Alberoni was born in the state of Piacenza. He was an intriguing and ambitious man, who rose to power suddenly, and fell as quickly into disgrace.

THE SIXTEENTH DAY.—In 1623, was born Sir William Petty, the eminent political economist.

THE SEVENTEENTH DAY.—In 1737, the Radcliffe Library, at Oxford, was founded; and in 1749, was born Dr. Edward Jenner, at Berkeley, in Gloucestershire. He introduced vaccination as a preservative from small pox, and on the

14th of May, 1796; a boy eight years of age, was first vaccinated with the matter taken from the hands of a milkmaid.

THE EIGHTEENTH DAY.—In 1692, died Elias Ashmole, an eminent antiquary and herald, who founded the Ashmolean Museum at Oxford, in 1682. He was in the seventy-sixth year of his age, at the time he died.

THE NINETEENTH DAY is dedicated to *St. Dunstan*, who was born at Glastonbury, in Somersetshire, A.D. 925, and died upon this day in 988. He was appointed Abbot of Glastonbury, then Bishop of Worcester, and afterwards of London, and finally Archbishop of Canterbury. He introduced the Benedictine monks into England.

In 1536, Ann Boleyn, second wife of Henry VIII., was beheaded; and in 1795, died James Boswell, the author of a "Life of Johnson," "Journal of the Tour to the Hebrides," and other works.

THE TWENTIETH DAY.—In 1471, was born at Nuremberg, Albrecht or Albert Dürer, a celebrated painter and engraver; and in 1506, died at Valladolid, in Spain, Christopher Columbus, well known as the discoverer of the New World.

THE TWENTY-FIRST DAY.—In 1790, died Dr. Thomas Warton, the poet, author of the "Progress of Discontent," and "the History of English Poetry."

THE TWENTY-SECOND DAY, this year is *Trinity Sunday*, which is the day set apart for the celebration of the festival held in honour of the Holy Trinity, and enjoined in the Council of Arles, 1260.

In 1688, was born Alexander Pope, the poet, author of the "Dunciad," the "Iliad," and other works.

THE TWENTY-THIRD DAY.—In 1543, died Nicolaus Copernicus, the illustrious astronomer.

THE TWENTY-FOURTH DAY.—In 1707, was born Carl von Linnè or Linnæus, the celebrated Swedish naturalist; and in 1819, was born Her Most Gracious Majesty Queen Victoria.

THE TWENTY-FIFTH DAY.—In 1805, died Archdeacon Paley, in his sixty-second year. He is well known as a learned divine, and the author of several works, particularly his "Natural Theology," and "Horæ Paulinæ."

THE TWENTY-SIXTH DAY, is dedicated

to *St. Augustine*, a monk sent to England by Pope Gregory the Great, to convert the Saxons. He accomplished his mission satisfactorily, for he converted King Ethelbert, who appointed him Archbishop of Canterbury, which he held until his death in 610.

In 1703, died Samuel Pepys, secretary to the Admiralty in the reigns of King Charles II. and King James II.

THE TWENTY-SEVENTH DAY.—In 735, died the Venerable Bede, a man of great piety and learning; and in 1564, died John Calvin, the celebrated reformer, in the fifty-fifth year of his age.

THE TWENTY-EIGHTH DAY.—In 1546, Cardinal Beaton, primate of Scotland, was assassinated in the castle of St. Andrew's, by a man named James Melvil.

THE TWENTY-NINTH DAY, is commonly called the *Restoration Day*, because in 1660, Charles II. was brought back to England, and restored to the throne of his ancestors. In some parts of England people wear oak-leaves and oak-apples (gilt) in their hats, in commemoration of the concealment of Charles in an oak-tree, after his defeat by Cromwell, at the battle of Worcester, September 3, 1651.

THE THIRTIETH DAY.—In 1431, Joan of Arc, "the Maid of Orleans," was burnt in the market-place at Rouen; in 1640, died Peter Paul Rubens, the celebrated Flemish painter, whose "Descent from the Cross," at Antwerp, is so justly admired; in 1778, died François Marie Arouet de Voltaire, so celebrated for his wit, satire, and sarcasm; and in 1829, died at Geneva, Sir Humphrey Davy, the illustrious philosopher and chemist, in the fifty-first year of his age.

THE THIRTY-FIRST DAY.—In 1847, died Dr. Thomas Chalmers, aged sixty-seven. He was well known as a divine, and for his extensive learning.

SUPERFICIAL KNOWLEDGE.—The character of the scholars of the present age will not be much injured or misrepresented by saying that they seem to be superficially acquainted with a multitude of subjects, but to go to the bottom of very few. This appears in criticism and polite learning, as well as in the abstruser sciences; by the diffusion of knowledge its depth is abated.

IMPORTANCE OF THE CORRECT USE OF TERMS.

FELICITY, in its proper sense, is but another word for fortunateness, or happiness; and I can see no advantage in the improper use of words, when proper terms are to be found, but, on the contrary, much mischief. For, by familiarizing the mind to *equivocal* expressions, that is, such as may be taken in two or more different meanings, we introduce confusion of thought, and furnish the sophist with his best and handiest tools. For the juggle of sophistry consists, for the greater part, in using a word in one sense in the premise, and in another sense in the conclusion. We should accustom ourselves to *think* and *reason* in precise and steadfast terms, even when custom, or the deficiency or the corruption of the language, will not permit the same strictness in speaking. The mathematician finds this so necessary to the truths which he is seeking, that his science begins with, and is founded on, the definition of his terms. The botanist, the chemist, the anatomist, &c., feel and submit to this necessity at all costs, even at the risk of exposing their several pursuits to the ridicule of the many, by technical terms, hard to be remembered, and alike quarrelsome to the ear and the tongue. In the business of moral and religious reflection, in the acquisition of clear and distinct conceptions of our duties, and of the relations in which we stand to God, our neighbour, and ourselves, no such difficulties occur. At the utmost, we have only to rescue words, already existing and familiar, from the false or vague meanings imposed on them by carelessness, or by the clipping and debasing misusage of the market. And surely happiness, duty, faith, truth, and final blessedness, are matters of deeper and dearer interest for all men than circles to the geometrician, or the characters of plants to the botanist, or the affinities and combining principle of the elements of bodies to the chemist, or even than of the mechanism of the perishable tabernacle of the soul can be to the anatomist. Among the *aids* to reflection, place the following maxim prominent: Let distinctness in expression advance side by side with distinction in thought.

NATURAL PHILOSOPHY.

THE PENDULUM.—(continued.)

THE length of the seconds' pendulum being always invariable at the same place—for gravity is always invariable—may be used as a standard of measure. Thus, the English inch is of such a length that 39.13939 inches are equal to the length of a pendulum vibrating seconds. From these measures of length, measures of capacity might be derived by taking their cubes, and measures of surface by taking their squares.

["A pendulum may have its centre of oscillation considerably beyond the limits of its actual dimensions, and a pendulum only one foot in length, may be made to oscillate as slowly as another 12 feet long. Suppose a rod of iron, *a b*, to be loaded at both ends, and suspended at *c*, so that it might vibrate freely, it is manifest that though the arc described in each vibration would be limited by the length measured from the point of suspension, the velocity of the ball, *b*, would be checked by the counter-weight of the ball, *a*, and the latter being moveable on the rod, the rate of vibration might be regulated at pleasure."—

Moffatt's "*Boy's Book of Science*, p. 54."

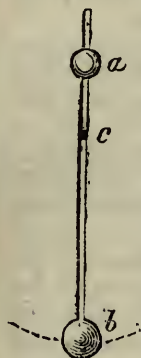


Fig. 140.

The metronome figured at page 170, is an example of this kind of pendulum.—W. T. K.]

CHAPTER XXVI.

OF PERCUSSION.

Of Impact, Central, Eccentric, Direct, Oblique.—Inelastic and Elastic Bodies.—Laws of Collision of Inelastic Bodies.—Changes of Figure of Elastic Bodies.—Phenomena of their Collision.—Of Reflected Motions.

IMPACT or percussion may take place in several different ways—as central, eccentric, direct, oblique.

Central impact takes place when the bodies in collision have their centre of gravity moving in the same right line.

Eccentric impact is when the directions of the motion of the centre of gravity of the bodies in collision make an angle with one another.

Direct impact is when the direction of the moving body is perpendicular to the surface on which it impinges.

Oblique impact is when the direction of the moving body makes some angle other than a right one with the surface on which it impinges.

The phenomena of percussion depend greatly on the physical character of the impinging bodies. The bodies may either be inelastic or elastic. Masses of clay or putty are illustrations of the former case, balls of ivory or steel of the latter.

It has already been shown, Chapter XVII, that if two inelastic bodies move in the same direction, their joint momentum, after impact, is equal to the sum of their separate momenta; and that, if they move in opposite directions, it is equal to the difference. Their velocity, after impact, is found by dividing their common momentum by the sum of their masses.

When a hard body impinges on an immovable mass, the particles of which can, however, recede, so as to admit the impinging body, the depths to which it will penetrate are as the squares of its velocity multiplied by its mass.

When elastic bodies impinge on each other, there is, during the time of their encounter, a change of figure. Thus, if we take the instrument, Fig. 141, and, having painted one of its ivory balls, *a*, let the other ball, *b*, touch it gently, the latter will receive on its surface a single point of paint. But if we raise this ball, and let it fall from a considerable distance upon the other, it will receive a circular mark of paint, showing that, during the percussion, the balls lost their spherical figure, and, instead of touching by a single point, they touched by a surface of considerable extent. Their instantaneous recovery of the spherical form, like the facility with which that form was lost, is due to their elasticity.

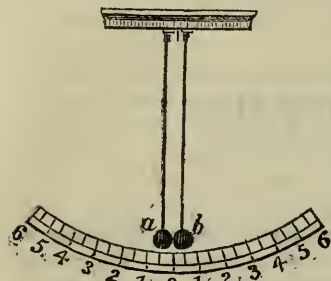


Fig. 141.

Whatever tends to impair the elasticity of such balls, tends, therefore, to change the phenomena of impact. Thus, if we make a cavity in one of them, and fill it partially with lead, the balls, after percussion, will not recede from one another as far as before.

The manner in which elasticity acts in these cases may be understood by considering the action of a spiral spring between the two balls, the length of it coinciding with the direction of their motion. When the balls fall upon its extremities, they give rise to compression, and the spring continually resists them at each successive instant. Their force, which was greatest at the moment of impact, is gradually overcome by the resistance of the spring, and finally vanishes. As soon as their velocity ceases, the spring can undergo no further compression, and is now able to begin to restore itself with a continually increasing force. Finally, it communicates to the balls the same velocity with which they originally impinged upon it.

When, therefore, a pair of elastic, spherical balls are made to impinge on each other, there is a compression of their particles in the direction in which the motion is taking place, so that the diameters, *a b*, Fig. 142, are less than before. A spheroidal form is, therefore, the necessary result. But just as with the imaginary spring in the foregoing case, so with the compressed particles in this. As soon as the motion of the bodies becomes 0, the elastic force of the compressed particles gives rise to movement in the opposite direction.

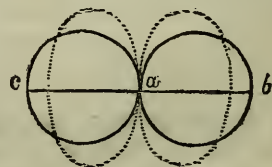


Fig. 142.

When two perfectly elastic bodies come in collision, the force of elasticity is equal to the force of compression, and the force of compression is equal to the force of the shock.

When two elastic bodies have struck each other, their recession will be with the same *relative* velocity with which they fell upon each other.

When two equal elastic bodies move toward each other with equal velocities, after percussion, they recede from each other with the same velocity.

When of two equal elastic bodies, one is in motion and the other at rest, the former, after collision, will communicate to the other all its velocity, and remain at rest itself. This phenomenon, and indeed much that is here said in relation to the impact of bodies, is well shown by an apparatus, such as Fig. 141, in which let the ball, *a*, be at rest, and let *b* fall on it from any height, after collision, *a* takes the whole velocity of *b*, and *b* itself remains at rest.

When of two equal bodies, moving in the same direction, one overtakes the other, they exchange velocities, and go on as before.

When two equal bodies, moving with different velocities, encounter each other, they exchange, and recede from one another in contrary directions.

If, in the instrument, Fig. 141, instead of having only two ivory-balls, we had a

large number suspended, so as to touch one another, it would be found, on letting the ball at one extremity impinge on the others, that all the intermediate ones would remain motionless, and the one at the farther extremity would rebound.

[Fig. 143, represents a bar of wood supported at both ends, and having six small balls of ivory suspended from it, $a b c d e f$, by silk cords. If we remove the ball, a , and allow it to impinge or strike against the ball, b , the whole line will not move forwards, but will appear to act only on the ball, f , at the other end of the row, causing it first to separate from the rest and to be moved in the same direction as the ball which communicated the motion; viz., from the position of f to f' . The ball, f' , will, in turn, impinge on the ball, e , and cause the ball, a to be separated to the distance of a' , which is not quite so great as f' from its original position of f . If we use any number of balls, the same thing takes place, and if we allow two balls from either end to impinge upon the others, we shall find that two balls are propelled from the opposite end; for example, $a b$, would separate $e f$ from the others.

Fig. 143.

—W. T. K.]

The motion, therefore, is transmitted through the entire series of balls; and it is the mutual reaction of the intermediate ones which keeps them at rest, the distant one rebounding because there is nothing against which it can react.

When an elastic ball strikes upon an immovable elastic plane, it will recoil with the same velocity with which it advanced. When the impact is perpendicular, the path of retrocession is the same as that of advance. Thus, if $a b$, Fig. 144, be the path of the advance, perpendicular to $c d$, the elastic plane, the recoil or retrocession will be in the same path, but in the opposite direction, $b a$.

When the path of the striking body is not perpendicular, but at some other angle to the elastic plane the recoil will be under the same angle, but on the opposite side of the perpendicular. Thus, if $n i$, Fig. 145, be the path of the striking body, $m m$, the elastic plane, the path after contact will be $i d$, such that the points, $n i d$, are in the same plane and the angle, $n i p$, is equal to the angle, $d i p$. To the former of these the name "angle of incidence" is given, to the latter "angle of reflexion."

The angle of incidence is the angle included between the path of the impinging body and a perpendicular, drawn to the surface of impact at the point of impact. And the angle of reflexion is the angle included between the path of the retroceding body and the same perpendicular.

The principles given in this Chapter are applied in many cases of practice. Thus, in the pile-engine, which consists of a heavy block, raised slowly by machinery between two uprights, and then allowed to fall suddenly on the head of the pile to be driven into the ground; if the block thus used as a hammer is too small, it fails to move the pile; and if its velocity is too great, it splits the head of the pile. A large mass, falling from a small height, is therefore used. Thus it may be readily shown, that if the hammer weighs 1,000 pounds, and it falls through a height of only four feet, the force with which it strikes the pile is equal to 120,000 pounds.

When gold is beaten into thin leaves the workmen cannot employ light hammers and use them quickly, for they would divide or fissure the gold: they use, therefore, heavier hammers, and move them more slowly.

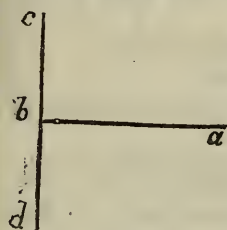


Fig. 144.

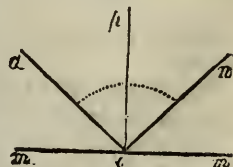


Fig. 145.

SECTION V.—THE ELEMENTS OF MACHINERY.

CHAPTER XXVII.

THE MECHANICAL POWERS.

Definition of Machines.—Number of Mechanical Powers.—Power.—Weight.—Principle of Virtual Velocities. — Definition of the Lever. — Three Kinds of Lever. — Conditions of Equilibrium.—Uses of Levers.—The Balance.—Weighing Machines.

By machines are meant certain contrivances employed for the purpose of changing the direction of moving powers, or of enabling them to produce any required velocity, or to overcome any required force.

It is to be understood that the force of any moving power can never be increased by the agency of any machine, the duty of which is to transmit the effect of that power unimpaired to the working point. Machinery cannot create power—it transmits it. Theoretically, this transmission is supposed to take place without loss, but practically there is always a certain degree of diminution arising both from imperfections of construction, and the agency of such impediments to motion as friction, rigidity, &c., the consideration of which we shall resume in its proper place.

In what follows it will, therefore, be understood that we speak of the action of machines theoretically, and apart from the intervention of these disturbing causes.

All machines, no matter how complex soever their construction may be, can be reduced to one or more of six simpler elements, which pass under the name of the “mechanical powers:” they are, the

Lever.	Wheel and Axle.	Wedge.
Pulley.	Inclined Plane.	Screw.

These mechanical powers, or simple machines, may, indeed, be further reduced to three: the

Lever.	Pulley.	Inclined Plane.
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In any machine the force or original prime mover passes under the name of THE POWER.

The resistance to be overcome, or that upon which the power is brought to bear through the intervention of the machine, goes under the name of THE WEIGHT.

The general law which determines the equilibrium of all machines, whether simple or compound, is as follows: “The power multiplied by the space through which it moves in a vertical direction is equal to the weight multiplied by the space through which it moves in a vertical direction.” The principle involved in this law passes under the name of “the principle of virtual velocities.”

The foregoing principle expounding the conditions under which the power and weight are in equilibrium, and the machine, therefore, in a state of rest, it follows, therefore, that “if the product arising from the power multiplied by the space through which it moves in a vertical direction, be greater than the product arising from the weight multiplied by the space through which it moves in a vertical direction, the power will overcome the resistance of the weight, and motion of the machine will ensue.”

THE LEVER.

The lever is the first of the elementary machines. In theory, it is an inflexible and imponderable line, supported on one point on which it can turn. In practice, it consists of a solid unyielding rod, working upon a point called a fulcrum.

Three varieties of levers are commonly enumerated. In the first, the fulcrum is between the power and the weight. [We see examples of this kind of lever every day. If we use a pin to extract a periwinkle from its shell, the pin is a lever of this class, the shell the fulcrum, and our fingers the power. If we poke the fire, the poker, A, is the lever, the bar, B, upon which it rests, is the fulcrum, the coals, C, the weight to be raised, and the hand, D, the power which raises it. The brake of a pump is a lever of this

class; the piston and the pump-rods being the weight to be raised, and the fulcrum the point on which it turns. A common claw-hammer, used to raise a nail from a piece of wood, is another familiar example; the hand, *a*, being the power, the wood, *f*, the fulcrum, and the nail, *n*, the resistance to be overcome. All instruments for cutting or holding, which are composed of two pieces crossing each other in the middle, such as scissors, shears, pincers, pliers, nippers, &c., are familiar examples; the pivot or joint being the fulcrum, the resistance or weight the paper, grass, &c., to be cut or seized, and the power applied by the hand. A common crowbar, applied to raise stones or other weights, is another familiar example; the fulcrum being another stone placed near to the one to be raised, and the power the man's hand, who raises it.—W. T. K.] In the second, the weight is between the power and the fulcrum, Fig. 148. [The oar, which urges a boat forward, is an excellent example of this kind of lever; the blade forced against the water being the fulcrum, the boat the weight, and the man's hand the power. The rudder of a ship acts in the same manner; and when we open a door, the hinge is the fulcrum, the air the resistance, and our hands the power. The common wheelbarrow is another example, the fulcrum being the point at which the wheel presses on the ground, the weight being the

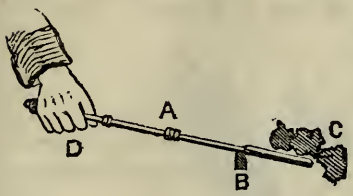


Fig. 146.

barrow and its load, while the power is represented by the two handles which the man lifts, and in proportion as he lengthens or shortens his hold on the handles, so is the power greater or less. The old sugar-chopper used by grocers is a very good example of a lever of the second kind, Fig. 149; the hinge, *F*, being the fulcrum, the sugar, *W*, the weight or resistance, and the handle, *P*, the power. Nut-crackers, and cork or lemon-squeezers, belong to this class. Two men carrying a sedan-chair is another example, and so is a pair of bellows. When a crowbar is placed underneath a stone, and the end of the bar raised, it becomes a lever of the second kind, the end resting on the ground being the fulcrum, the stone the resistance, and the upward movement of the man's hand the power.—W. T. K.] In the third, the power is between the weight and the fulcrum,

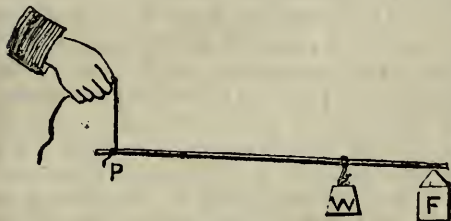


Fig. 148.

Fig. 150. [This kind of lever possesses certain advantages over the two former, because what is lost in power is gained in velocity, a small power causing the long arm of the lever to move over a great space; of course when we say that what is lost in power is gained in velocity, we only speak comparatively; a familiar example of this class is a man using a flail with both hands. The treddle of a turning-lathe is another example, the end which rests on the ground is the fulcrum, the foot of the man which presses on the board, near the fulcrum, is the power, and the crank upon the axis of the fly-wheel, which is attached to the other end is the weight. The most interesting examples

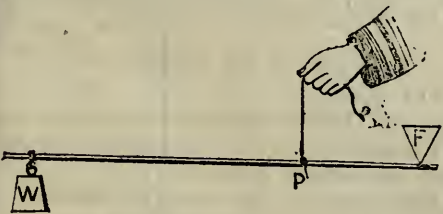


Fig. 150.

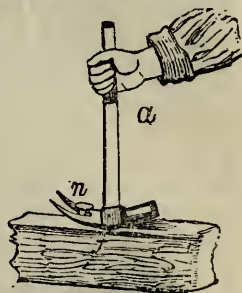


Fig. 147.

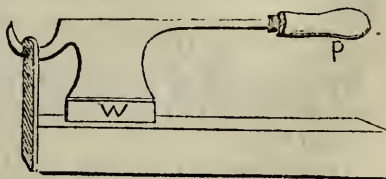


Fig. 149.

of the application of this class of levers are to be found in the structure of animals, particularly the arm and fore-arm of man, and the lower jaw, as shown in Figs. 151, and 152. In the former, the lower end of the arm-bone, *a*, becomes the fulcrum, the bones of the fore-arm, *c*, *b*, the lever, and the *biceps flexor cubiti*, *d*,

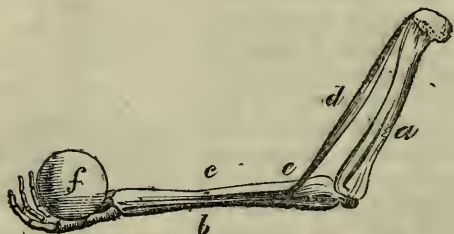


Fig. 151.

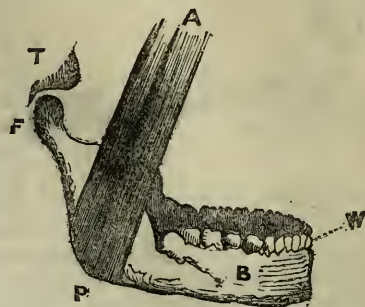


Fig. 152.

or the muscle which bends the fore-arm, and is inserted, at *e*, into the posterior part of the tubercle of the radius, is the power which raises the weight, *f*, held in the hand. The fulcrum, *F*, of the lower jaw, *B*, is formed by the *condyle*, or end of the bone, which rests against the temporal bone, *T*, while the resistance or weight, *W*, is at the opposite end, and acted upon by the *masseter* muscle, *A*, placed at the angle of the jaw bone.—W. T. K.] There are also other species of lever, such as the bent lever,

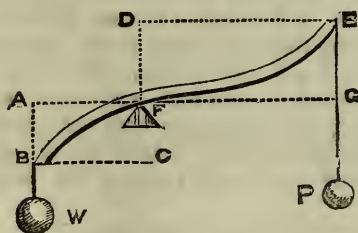


Fig. 153.

the curvilinear lever. The mode of action and theory of all are the same. [The same advantage cannot be derived from a bent lever as from a straight one of the same length. Let *A B*, Fig. 153, represent a curved lever, which is supported at *F*, having the weight, *W*, attached at *B*, and the power, *P*, applied at *E*. If we wish to find the momentum of the weight, we have only to multiply its weight by the ideal lines *A F*, or *B C*; and the momentum of power will be found by multiplying its weight by the ideal lines *D E*, or *F G*.—W. T. K.]

By the principle of virtual velocities, it appears that “any lever is in equilibrium when the power and the weight are to each other inversely as their distances from the fulcrum.”

As illustrative instances of this—if in a lever of the first kind, in equilibrio, the power and the weight are equal, they must be at equal distances from the fulcrum. If the power is only half the weight, it must be at double the distance from the fulcrum, if one-third the weight, triple the distance, &c.

When, therefore, it is proposed by the intervention of a lever to cause a given power to overcome a given weight, it is necessary that the power multiplied by its distance from the fulcrum, should give a greater product than the weight multiplied by its distance from the fulcrum. Thus, in Fig. 154, let *P* be a power of six pounds, operating on a lever of the first kind, at a distance, *P c*, from the fulcrum, *c*, of seven inches; let *W* be the weight to be overcome, and let it be seven pounds, with a distance, *W c*, of six inches from the fulcrum. Now the power multiplied into its distance is equal to forty-two, and the weight multiplied into its distance is also equal to forty-two; the lever is, therefore, under the law just stated in equilibrio. But if we increase the distance of *P* from *c*, or increase *P* itself, or do both, then the product of *P* into its distance from the fulcrum will increase, the lever will move, and the resistance of the weight be overcome.

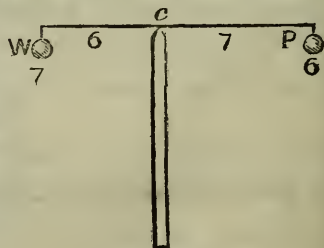


Fig. 154.

LESSONS IN DRAWING.

FOURTH LESSON.

Now that your hand has become accustomed to trace straight and curved lines upon the paper with accuracy, you should practise some combinations of the two by copying the examples that are now before you.

Before you commence copying the simple examples furnished for the present lesson, it will be well to draw your attention to some few important points connected with this advanced stage of your drawing lessons.

We have endeavoured before to make you acquire ease and command of your hand and pencil, by the most simple examples; but now a greater necessity exists for you to govern your hand, as the examples that will be given from time to time will be more and more difficult. It would be as absurd to expect a child to write a long letter, before he had practised his letters, as to expect you to copy a drawing before you had acquired freedom and command of your hand.

By *freedom of hand*, we do not intend dashing, irregular drawing, without any fixed purpose. It is not intended that your pencil should fly from one side of the page to the other and back again, and allow the *drawing* to take its chance; nor is it intended that your pencil should be wielded with a flourish like M. Jullien's *bâton*. No! we mean by freedom of hand, an easy, graceful motion, which will allow the pencil to pass freely over the paper, the same as the pen of a good writer, and not to crawl, or go over it by fits and starts, cramping and stiffening the outline. Of course, freedom of hand requires to be governed or checked, and therefore, you must always couple it with command of hand.

By *command of hand*, we mean that steadiness, ease, and precision, that enables you to *commence* a line at *any* particular place, and to stop when you please, so that when two dots are placed upon your drawing-paper, and you are required to draw a line between them, the line shall not fall short of, or go beyond, the dots; and when it is necessary to draw a line to the right or left of a perpendicular line,

you shall be able to do so, whether the line be curved or straight. Freedom of hand will enable you to make a *level* line, level, and not up and down, and a perpendicular line perpendicular, and *not* oblique, as is too often the case with beginners; hence the tumble-down appearance of their houses, gate-posts, and other objects. Avoid these faults as a sailor would a quicksand, and preserve your early copies, in order that they may act as beacons, to warn you of the danger of carelessness in drawing, for, be assured, that if you once contract a slovenly method of drawing, you will not easily, if ever, be able to leave it off.

We cannot urge upon you too strongly the necessity of being in a proper position during the time you are drawing, and we trust that you have not forgotten our former remarks on the subject (p. 136), for much of your success will depend upon this. In drawing lines the hand should rest upon the two last fingers,—if the lines are short the motion of the hand should not extend beyond the wrist-joint; but if the lines are long, then the hand will glide over the paper easily, if it is carefully balanced and rests upon these fingers, while the motion of the hand proceeds from the elbow or from the shoulder.

As you have already practised curved lines and circles, you will no doubt be able to copy this example, which is the

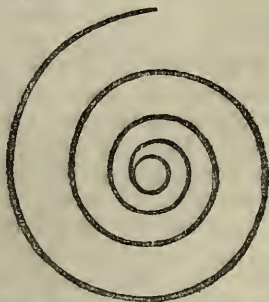


Fig. 13.

outline of the volute of an Ionic capital from the Erechtheum at Athens. It is needless to describe how it should be drawn, because if you have attended to the rules already given, you will be able to know how to proceed at once. Copy this example over and over again, enlarg-

ing and diminishing the copy, until your eye has become familiar with the figure; then endeavour to form its outlines without having the example before you. When you have accomplished your task, you will be better prepared to copy the next example.

This drawing is a combination of curved and straight lines so arranged that they form the outline of the base of a column, and by copying this example frequently, you will acquire a very good idea of proportion. If you had not exercised yourself in drawing straight and curved lines, you could not have drawn this figure. You may, therefore, look upon straight and curved lines as the letters or alphabet of drawing.

Here is another example, composed of straight and curved lines, but differently arranged. In drawing this, commence by making a *faint* horizontal line upon the paper; then place a dot at a proper distance above, for the centre part of the

arch, from this dot draw the right-hand curved line until it meets the horizontal one; then place another dot a little above the horizontal line, at nearly the same distance as the height of the arch from it, and draw two parallel curved lines close together, from the top of the first curved line to the dot you have just placed on the paper. You have now formed the outline of the arch. Draw a horizontal line from each side of the top of the arch, and at the respective distances draw other lines parallel to it; then draw perpendicular lines between the horizontal ones, and you will now have formed the masonry. Sketch in the lines of the two banks, commencing with the left one, and afterwards sketch in the stones on the right

of the base of the arch. At rather more than half the length of the left-hand curved

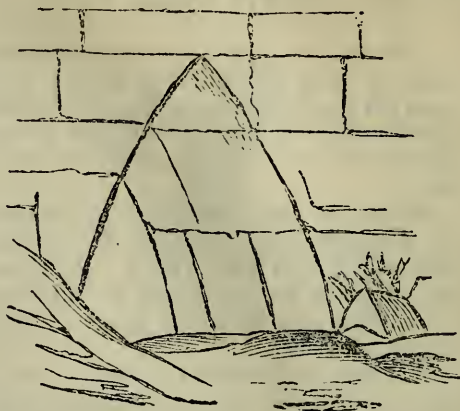


Fig. 15.

lines place a dot, and another at about two-thirds the distance from the base of the right-hand curved line; connect these two dots by a curved line, and then sketch in the masonry of the archway, as in the example; all that now remains for you to do is to fill in the shading, which is done by making short parallel strokes at equal distances from each other, as in the example before you.

The next object that you are required to copy, is a pyramid, and you observe

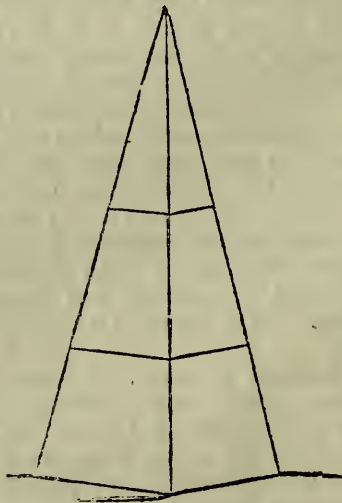


Fig. 16.

that the first example is sketched only in outline, in order that you may clearly understand how it is done.

When you have drawn the outline correctly several times, you may commence the next example (fig. 17) which,

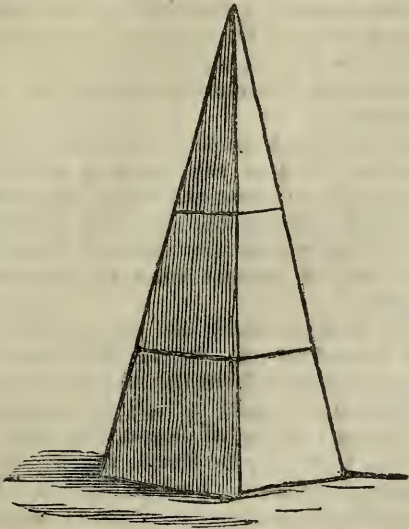


Fig. 17.

you observe, is carefully shaded by drawing fine perpendicular parallel lines between the transverse lines, and all of them at equal distances. The shading at the base is drawn in a similar manner; the only difference being that the lines are horizontal, instead of perpendicular.

The next example is the outline of

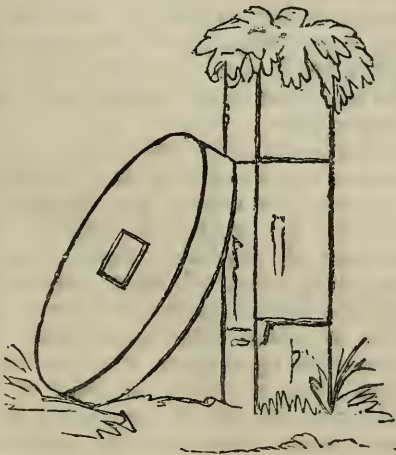


Fig. 18.

a pillar with a millstone resting against it (fig. 18); and when you have sketched this, it must be filled in, the same as the

other example (fig. 19), which shows the same objects shaded, according to the method we have already pointed out. The weeds and grass require a few extra touches with an H B pencil, and the outline should be strengthened in the dark parts.

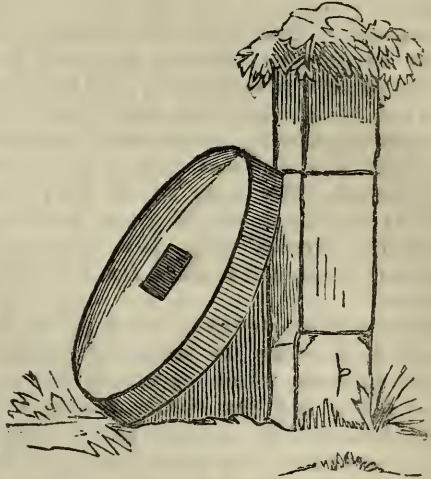


Fig. 19.

Practise these examples frequently particularly the weeds at the top of the pillar, and the shading.

When you are able to draw these examples as they are represented here, draw them backwards; in other words, place the millstone on the right instead of the left of the pillar.

Draw examples 17 and 19, and shade them as if the light was on the left.

TEETH OF ANIMALS.—The teeth of animals are formed of three distinct substances, which are variously disposed in the different orders according to the habits and economy of the species. The nucleus of the tooth is a congeries of blood-vessels and nerves, called the *pulp*, by which the calcareous hard parts are elaborated. The pulp is surrounded by a covering of a very dense substance, composed of phosphate of lime, with albumen and gluten, termed dentine ivory; and this dentine is encased in a still harder material, called *enamel*. In the elephant and other herbivora there is a coarse kind of dentine termed *crusta petrosa*, interstratified with the enamel and dentine.—M.

LESSONS IN FRENCH.

NOUNS—CONTINUED.

Of number in the Nouns which are Objects of another Noun. — Substantives immediately governed by another with the preposition *of, de*.

Singular. The hand of woman, *Une main de femme*; The act of a fool, *Une action de fou*; A child's play, *Un jeu d'enfant*; A horse's tail, *Une queue de cheval*; A statue of marble, *Une statue de marbre*.

Plural. The hands of woman, *Des mains de femme*; The acts of a fool, *Des actions de fou*; A child's plays, *Des jeux d'enfant*; Horses' tails, *Des queues de cheval*; Statues of marble, *Des statues de marbre*.

Here the substantives which follow the preposition modify the subject designated by the first one, which represents the principal idea; and the words, *woman, fool, child, &c.*, used in a vague and indefinite sense, serve less to express the idea of the object which they represent, than to qualify the substantive with which they are united by the preposition *of, de*; in fact, a *woman's voice* is a *feminine voice*, the *action of a fool* is a *foolish action*, the *play of a child* is a *childish play*, &c.

In all cases similar to the above, and where no peculiar reason requires the plural, the substantive employed as a regimen or object remains in the singular.

Observation. In conformity with this rule we write, Stumps, *Des troncs d'arbre*, with *arbre* in the singular; but speaking of trees to be planted again, we say, Sets of trees, *Des pieds d'arbres*, because here the words *pieds d'arbres* are taken for the trees themselves.

However, it is customary, and the Academy approves of it, to write *des pieds de giroflée*, plants of gillyflower, *des pieds de basilic*, plants of basil, *des pieds de marjolaine*, plants of marjoram, because these plants, composed of several slips, do not present a distinct idea of individuality; and, besides, we generally say, *de la giroflée* some gillyflower, *du basilic*, some basil, &c.

Rule. When the substantive, used as an object, implies necessarily the idea of plurality, it must be used in the plural; as, A forest of oaks, *Une forêt de chênes*;

A couple of horses, *Une couple de chevaux*; A merchant of engravings, *Un marchand de gravures*.

Observations. A merchant or some merchants of wine, *Un marchand ou des marchands de vin*; A merchant of rich wines and liquors, *Un marchand de vins fins et de liqueurs*.

In the first example we write *vin* in the singular, because this word is taken indefinitely, and does not imply the idea of plurality; but in the last, *vins* is written with an *s*, because the mind is compelled to think of several sorts of wines and liquors.

Of cases in which two Nouns, united by the Preposition of, express the idea of a thing formed by Extraction or Composition.

Singular. A jelly of apples, *Une gelée de pomme*; Syrup of lemon, *Du sirop de limon*; Olive oil, *De l'huile d'olive*.

Plural. Stewed pears, pigeons, *Une compôte de poires, de pigeons*; Marmalade of apricots, *Une marmelade d'abricots*; A dish of chesnuts, *Une assiette de marrons*.

Here the preposition and the noun which follows are no longer used only to modify the subject of the preposition, but they show how it is constituted, or composed, if we may say so, and we call this last noun *determinative*.

Rule. The determinative remains in the singular when it concurs with the constitution of the subject by *extraction*, as *apple, lemon, olive*, in the foregoing examples; but it is employed in the plural if the formation of the subject takes place by *composition*.

Let us explain this rule. There is *extraction*, when the article which is employed to compose the *subject*, has changed its nature in the compound which it has been used to produce; thus, when we make jelly, syrup, oil, we employ only a part of the apples, lemons, and olives; and neither of those preparations keep the form, nor the appearance, of those fruits; in these cases we think but little of the individuality of either fruit, and their names must remain in the singular. When, on the other hand, the article used to form the *subject* of the preposition remains *entire*, or nearly so, there is no *extraction*, but *composition*, the idea of individuality becomes striking, recalls to

the mind that of plurality for the whole, and the *determinative* must accordingly take the plural; it is the case with the words *poires, pigeons, abricots, marrons*, which remain entire in the composition of the subject, and may be counted one by one; in the *marmelade*, the *individuals* are not so distinct, it is true, but the apricots have not entirely changed their nature, as in a jelly, syrup, &c.

Of cases in which two Nouns being separated by the Preposition of, the first expresses an idea of Capacity or Agglomeration.

Singular. A barrel of vinegar, Un baril de vinaigre; A bushel of wheat, Un boisseau de blé; A bouquet of jasmine, Un bouquet de jasmin.

Plural. A barrel of olives, Un baril d'olives; A bushel of beans, Un boisseau de haricots; A bouquet of roses, Un bouquet de roses.

Rule. When the first substantive expresses an idea of capacity or agglomeration, the second may be considered as being *determinative*, and always remains in the singular, if it specifies a thing which cannot be, or is not usually, *counted*; in all other cases, it always takes the plural. The above examples leave no ambiguity about the application of this rule.

Observations. The rules which we have just given are not strictly applicable, and it is necessary to examine carefully how the determinative must be understood. In the locution, A juice of herbs, un jus d'herbes, the determinative *herbs* is plural, although the juice is made by extraction, and the herbs have entirely changed their nature; we are induced to do it, not only because several herbs enter into its formation, but because those herbs are of a different nature.

On the other hand, we write, A porridge of beans, Une purée de haricots; A cullis of craw-fish, Un coulis d'écrevisses; A pot of preserves, Un pot de confitures, because those words, *beans, craw-fish*, and *preserves*, in French, are most generally used in the plural; for we do not say, I love the bean, the craw-fish, the preserve, J'aime le haricot, l'écrevisse, la confiture; but, Les haricots, les écrevisses, les confitures. But we write, A porridge of potatoes, Une purée de pomme de terre, because we say, the potato is good, La pomme de terre est bonne.

When a qualificative is joined to the determinative, it restricts and particularizes its meaning, and consequently disposes it to take the plural; thus, although we think it should be written, I prefer to draw heads of women rather than of men, J'aime mieux dessiner des têtes de femme que des têtes d'homme, we should employ the plural in two of the following sentences: Cannibals used to cut off the heads of men killed in battle, Les cannibales coupaient les têtes d'hommes tués sur le champ de bataille; There are two kinds of rights in law, Il y a deux espèces de droit; There are several breeds of horses, Il y a plusieurs espèces de chevaux.

In the second example, the singular is used, because we wish to say, Law is divided into two classes, public law and private law, Le droit se divise en deux classes, le droit public et le droit privé.

In the last example, the plural is used, because we wish to say, There are horses of several breeds, Il y a des chevaux de différentes espèces.

By taking the trouble to analyze the sentences which appear doubtful to the mind, it is easy to avoid committing any faults.

Of Nouns used with the Preposition of, de, but not preceded immediately by another Noun.—Of, preceded by an adjective or a past participle; as,

Singular. A child full of good disposition, Un enfant plein de bonne volonté; A prince thirsting for fame, Un prince altéré de renommée; A painter full of talent, Un peintre rempli de talent.

Plural. A man full of vices, Un homme plein de défauts; An author craving applause, Un auteur insatiable de louanges; A young lady full of talents, Une jeune personne remplie de talents.

The least reflection is sufficient to determine, in all cases similar to these, whether the singular or plural must be used. *Bonne volonté* is in the singular, because we do not say, *Des bonnes volontés*; *défauts* is in the plural, because we would not say, *A man full of vices*, if he had only one vice.

Gloire, taken in a general sense, is never used in the plural; but it should be, if we had to express, He is craving for all sorts of glory, Il est affamé de tous les genres de gloires; because here *glory* is particular-

ized, and we understand there are several sorts of it.

Louanges, praises, cannot possibly be in the singular, because *one* of them alone would not be enough for a *craving man*.

Talent, in the painter's case, is singular, because we mean but *one* talent of an eminent order; but in the other instance, we intend to say that the young lady possesses all the talents which are acquired by a complete education.

Of *Substantives preceded, as Determinative, by any Preposition but of, de*.—Preposition *à*; as,

Singular. To travel on foot, *Voyager à pied*; A safe with a secret lock, *Un coffre à secret*.

Plural. To jump with the feet close, *Sauter à pieds joints*; Horned cattle, *Des bêtes à cornes*; To go on foot, to be on foot, a footman, *Aller à pied*, *être sur pied*, *valet de pied*, are expressions which usage has consecrated in the singular, because the mode in which the word *foot* is used implies only a modification of the words *aller*, *être*, *valet*, without the mind being troubled with the idea of the number of feet; but in this phrase, *Sauter à pieds joints*, the word *joints*, awaking naturally the idea of two feet, requires the plural.

Secret is in the singular, because we think only of a lock which is a secret *one*; but *cornes* is in the plural, because we mean animals that always have two horns.

Preposition *en, in*; as,

Singular. Constant in love, *Constant en amour*; To fly from flower to flower, *Voler de fleur en fleur*; I made a marmalade of them, *Je les ai mis en marmelade*; A house covered with slate, *Une maison couverte en ardoise*.

Plural. Fertile in expedients, *Fertile en expédients*; To lie in, *Etre en couches*; They are cut to pieces, *Ils sont taillés en pièces*; A gown trimmed with pearls, *Une robe garnie en perles*.

Amour, in the plural, would be nonsense applied to *constant*.

Fertile conveys the idea of more than one expedient, or else the sentence would have no sense.

It is easily perceived when the plural must be used after a certain class of ad-

jectives; as, *full, filled, craving, rich, abounding*, and others similar to them. *De fleur en fleur* signifies, *from one flower to another*; it is clear that a fly, or butterfly, cannot leave two flowers at once.

Marmelade is in the singular, because there is but one preparation so called.

Pièces is in the plural, because they have been cut into a great number of pieces.

Ardoise is in the singular, because the slates which cover the house are taken as a whole, the mind not being occupied with the idea of plurality in regard to them.

Perles is in the plural, because the mind divides them, counts them, if we may say so, and is pleased by exaggerating their number.

The preposition *par, by*; as,

Singular. I gave him my property by deed, *Je lui donnai mon bien par contract*.

Plural. They divided themselves into troops, *Il se divisèrent par troupes*.

There is but *one* contract, and there are several troops.

The preposition *pour, for*; as,

Peter, shoemaker for men only, *Pierre, cordonnier pour homme*.

Homme is used in the singular, because its meaning is vague and indefinite, and stands here as a mere qualification.

The preposition *sans, without*; as,

Singular. I am without bread or money, *Je suis sans pain et sans argent*.

Plural. He is without shoes, *Il est sans souliers*.

The words *pain* and *argent* have no plural in this acceptance; besides, the preposition *sans*, meaning a complete exclusion, must generally be followed by the singular, unless we are compelled to think of several objects, as is the case in the other examples; (a man always wears two shoes.)

The preposition *sur, upon, on*; as,

Singular. To receive letter after letter, *Recevoir lettre sur lettre*.

Plural. To begin anew, *Recommencer sur de nouveaux frais*.

Lettre sur lettre, means, a letter after another letter; it is an expression similar to that of *de fleur en fleur*, from flower to flower.

Frais has no singular; that is the rea-

son why we write, To travel at a great expense, *Voyager à grands frais.*

Remarks on the Preceding Chapters.—We have already said enough on this subject to enable the reader to ascertain with accuracy in what cases he must use the plural or the singular in locutions of this kind; it is easily perceived that the singular is more generally employed than the other number, which must be rejected whenever the *sense* of the sentence does not convey the idea of plurality in a clear and distinct manner. But, in the mean time, particular care must be taken to study the real meaning of the sentence, as being the only sure guide in the case.

There are, however, many instances where either number may be employed indifferently. Let us try to explain still more explicitly what characterizes each number.

General Rule.—If we speak of a *species* or of a *kind* taken generally, the singular must be used.

If the mind refers more particularly to individuals, the plural must be used.

If we say, During lent, Catholics live wholly upon fish, *Les Catholiques, pendant le carême, ne se nourrissent que de poisson*, we use the singular for *poisson*, because we think only of the kind of food, without any reference to the number of fish.

But if we say, Lobsters and crabs live only on fish, *Les homards et les crabes ne vivent que de poissons*, we represent to ourselves *lobsters* and *crabs* living upon a number of fishes; the idea dwells upon the individuals of the fish tribe, and accordingly the plural is used.

In fine, there are cases in which the plural seems to give more force to the expression; as, for instance, if we say, as a matter of fact only, Catacombs are filled with skulls and dead bones, *Les catacombs sont remplies de têtes et d'os de mort*.

But, if we wish to move an audience, we should say, Think of the horrid picture which strikes our eyes; a valley covered with skulls and dead bones, *Figurez-vous l'affreux tableau qui frappe nos regards; une vallée jonchée de têtes et d'os de morts*.

The mind refers, in the first instance, to *bones* as those of a corpse; while, in the other, it is struck by the horror of so many persons killed and having their bones left in the valley.

The Dictionary of the Academy should not be consulted for the explanation of this difficulty of our language; because, being the result of the co-operation of many, it too often contains rules implying contradiction to one another. It is by common sense and reasoning, according to the rules we have laid down, that the student must be guided. We will add some few more illustrations, so as to leave as little doubt as possible on the subject:

Singular.

Fancies of a woman.	Des caprices de femme.
Heaps of grass.	Des tas d'herbe.
To fight with the fist.	Se battre à coups de poing.
Vessels loaded with linen	Des vaisseaux chargés de toile.
Some pots of basil, of butter.	Des pots de basilic, de beurre.
A merchant of feathers.	Un marchand de plume.
Merchants of straw, hay, cider.	Des marchands de paille, de foin, de cidre.
A merchant of music.	Un marchand de musique.
Merchants of wine, but-ter, fish, cod-fish, orange flower.	Des marchands de vin, de beurre, de poisson, de morue, de fleur d'orange.

Plural.

Female boarding-house.	Une pension de femmes.
A heap of medicinal herbs.	Un tas d'herbes médicinales.
To scratch with the nails.	Se battre à coups d'ongles.
Vessels loaded with cod-fish.	Des vaisseaux chargés de morues.
A pot of flowers, of pinks.	Un pot de fleurs, d'œillets.
A merchant of pens.	Un marchand de plumes.
A merchant of cloths from Elbeuf, Louviers, of white linen, of coarse linen.	Un marchand de draps d'Elbeuf, de Louviers, de toiles blanches, de toiles communes.
A merchant of engravings.	Un marchand d'estampes.
A merchant of rich wines, salt butter, herrings, eels, carps, lobsters, flowers.	Un marchand de vins fins, de beurres salés, de harengs, d'anguilles, de carpes, de homards, de fleurs.

In all the above examples of the singular, the second substantives are used in a general and indefinite sense, as mere qualificatives; whereas, in the plural, these same words are taken in a sense of individuality.

For instance, *des caprices de femme*, are caprices which are attributed to women in general; but, *une pension de femmes* is composed of individuals, and the word *femmes* conveys the idea of plurality.

Des marchands de plume are men who sell quantities of feathers to make beds; we cannot have the idea of counting these feathers; but *un marchand de plumes* is a man who sells pens to write with, and at once we see that we may buy one, two, or twenty of them; the sense is individual, definite.

Merchants of *straw, hay, cider*, are men who do not sell singly *one, two straws, &c.*, but who sell, as a whole, *straw, hay, &c.*, then the sense is indefinite, and does not admit of plurality; but a merchant of *trees, apricots, grapes, &c.*, always sell those articles by the piece, or, on account of their number, sells them by the quantity; then the sense is individual; you may buy *an apricot, two trees, &c.* We could not, without useless repetition, continue the analysis of the other examples, which has been previously given.

We will terminate this review by mentioning once more, that in cases similar to those already noticed, the mind must decide the question, by giving to sentences their proper signification.

CHEMISTRY.

EXPANSION—CONTINUED.

PRACTICAL applications of the laws of expansion in solids are frequently made with great advantage in the arts. The rivets which hold together the plates of iron in steam-boilers are put in and secured while red hot, and on cooling draw together the opposite edges of the plates with great power. The wheelwright secures the parts of a carriage-wheel by a red hot tire, or belt of iron, which, being quickly quenched before it chars the wood, binds the whole fabric together with wonderful firmness. The walls of the Conservatory of Arts, in Paris, were safely drawn into a vertical position after they had bulged badly, by the alternate contraction and expansion of large rods of iron passed across it, and so secured by screw-nuts and heated by Argand lamps as to draw the walls inward. Towers of churches and other buildings have been thrown down or otherwise injured by the expansion of large iron rods (anchors), built into the masonry with the design of

strengthening them. The mechanical arts are, in fact, full of beautiful applications of the principles of expansion.

Unequal Expansion of Water.—The general law of expansion for nearly all solids and fluids, especially within the limits of the freezing and boiling points of water is, that each solid or fluid expands or contracts an equal amount for every like increase and reduction of temperature, each body having its own *rate* of alteration. There are, however, some exceptions to this law, of which water offers a remarkable example; the comfort, and even habitability of our globe, are in a great degree dependent on this exception to the ordinary laws of nature. We will briefly explain it, and the effects resulting from it.

If for experiment we fill a large thermometer-tube or bulbed glass, with water, and place it in a cold situation,* where we can observe the fall of the temperature by the thermometer, we shall see the column descend regularly with the temperature, until it reaches 39°·1 F., when the contrary effect will take place; the water then begins suddenly to rise in the tube, by a regular expansion, until the temperature falls to 32°, when so sudden an expansion takes place as to throw the water in a jet from the open orifice, and the ball at the same time is not unfrequently broken from the solidification of the water. If, on the other hand, we heat water in such an apparatus, commencing at 32°, we shall find that, until the temperature rises to 40°, the fluid, in place of expanding, as we might expect, will actually contract. Water has, therefore, its greatest density at 39°·1, and its density is the same for equal temperatures above and below this point; thus we shall find it having a similar density at 34° and 45°, and this is true until it reaches the point of solidification at 32°.

Beneficial Results.—Let us now observe what useful end this curious irregularity in the expansion of water subserves. When winter approaches, the lakes and rivers, by the contact of the cold air, begin to lose their heat on the surface: the colder water, being more dense, falls to the bottom, and its place is supplied by warmer water

* A freezing mixture of salt and ice surrounding it will answer the purpose very well.

rising from below. A system of circulation is thus set in motion, and its tendency, if the mass of water is not too large, is to reduce the whole, gradually, to the same temperature throughout. When, however, the water has cooled to 39°F , this circulation is suddenly stopped by the operation of the law just explained: below this point the water no longer contracts by cooling, and of course does not sink, but, on the contrary, expanding, as before explained, it becomes relatively lighter, and remains on the surface; the temperature of this layer or upper stratum gradually falls, until the freezing point is reached and a film of ice is formed. But as ice is a very bad conductor, the heat now escapes with extreme slowness; all currents tending to convey away the cooler parts of the water are arrested, and the thickness of ice can increase only by the slow conduction through the film already formed; the consequence is, that our most severe winters fail to make ice of any great thickness. Other causes, also, which we shall presently explain, co-operate at all times to render the freezing of water a very slow process. If this irregularity did not exist, there is every reason to believe that the entire waters of the globe* would freeze solid: when any portion reached the point of congelation, all would become solid at once, like a mass of molten metal cooled in a crucible. We cannot fail to be impressed by the wisdom of that Power, which not only frames great general laws for the government of matter, but also makes exceptions to them when the welfare of His creatures requires them.

The expansion of all gases and vapours is the same for an equal degree of heat; and equal increments of heat produce equal amounts of expansion. This rate of expansion is not altered by any change in the compression or elastic force of the gas, and amounts to $\frac{1}{273}$ th part of the volume of the gas at 0° for each degree of Fahrenheit's scale.

When gases are near the point of compression at which they become liquid, this law becomes irregular.

The expansion of air by heat, is one

* Sea-water above 32° is not subject to the exception but it is below 28° .

cause of winds and atmospheric currents. The trade-winds and other regular winds so well known to mariners, are the joint result of the motion of the earth on its axis, and the rise of heated air from the equatorial regions of the globe.

2. COMMUNICATION OF HEAT.—EQUILIBRIUM OF TEMPERATURE.

Equilibrium of Temperature.—A heated body, like a red-hot cannon-ball, cools when removed from the source of heat; 1, by communicating its heat to the substance supporting it, (conduction;) 2, by the contact of the atmosphere conveying it away, (convection;) and 3, by direct radiation, or a transmission of rays of heat in all directions through the surrounding air, as light is transmitted. All these causes act to withdraw the excess of heat from the heated body, which thus divides itself equally among surrounding bodies according to their several powers of receiving it, until a perfect equilibrium of temperature is produced, the hot body has become cool, and the others have gained heat.

In liquids of gases, this uniform diffusion or distribution of temperature takes place rapidly, because of the mobility of their particles; but in solids, much more slowly. Its diffusion has no connection with the conducting power of the fluids, however, which are among the worst of conductors.

Conduction of Heat.—Each solid has its own peculiar power of conducting heat, but in all it is a progressive operation, the heat seeming to travel from particle to particle with greater or less rapidity, according to the conducting power of the solid. If we hold a pipe-stem, or glass rod, in the flame of a spirit-lamp or candle, we can heat it to redness within an inch of our fingers with no inconvenience; but a wire of silver or copper would burn us in a very short time when at the distance of many inches from the flame. This is owing to a difference in-

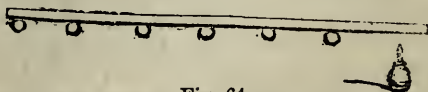


Fig. 64.

herent in these solids, which we call conducting power. The progress of con-

ducted heat in a solid is easily shown, as in fig. 37, representing a rod of copper, to which are stuck, by wax, several marbles at equal distances; one end is held over a lamp, and the marbles drop off, one by one, as the heat melts the wax; that nearest the lamp falling first, and so on. If the rod is of copper, they all drop very soon; but if a rod of lead or platinum is used, the heat is conveyed much more slowly. Little cones of various metals, and other substances, may be tipped with wax or bits of phosphorus, and placed on a hot surface. The wax will melt, or the phosphorus inflame, at different times, according to the conducting power of the various solids. Accurate experiments have been made, which have enabled us to arrange most solids in a table showing their conducting powers. The metals, as a class, are good conductors, while wood, charcoal, fire-clay, and similar bodies, are bad ones. Thus gold is the best conductor, and may be represented by the number 1000; then marble will be 23.5, porcelain 12, and fire-clay 11. Metals compared with each other are very different in conducting power. Thus:

Gold.... 1000	Iron.... 374.3	Marble .. 23.6
Silver .. 973	Zinc.... 363	Porcelain 12.2
Copper.. 898.6	Tin 303.9	Pipeclay 11.4
Platinum 381	Lead .. 179.6	

The sense of touch gives us a good idea of the different conducting power of various solids. All the articles in an apartment have nearly the same temperature; but if we lay our hand upon a wooden table, the sensation is very different from that we feel on touching the marble mantel or the metal door-knob. The carpet will give us still a different sensation. The marble feels cold, because it rapidly conducts away the heat from the hand; while the carpet, being a very bad conductor, retains and accumulates the heat, and thus feels warm. Clothing is not itself warm, but being a bad conductor retains the heat of the body. A film of confined air is one of the worst conductors; loose clothes are therefore warmer than those which fit closely. For the same reason, porous bodies, like charcoal, are bad conductors; and a wooden handle enables us to manage hot bodies with ease.

The conducting power of fluids is very small. This is contrary to the general impression of people, who think, from the ease with which a teakettle boils, that liquids conduct heat with facility. A simple and instructive experiment will prove to us that the conducting power of fluids is very low. A glass, like that

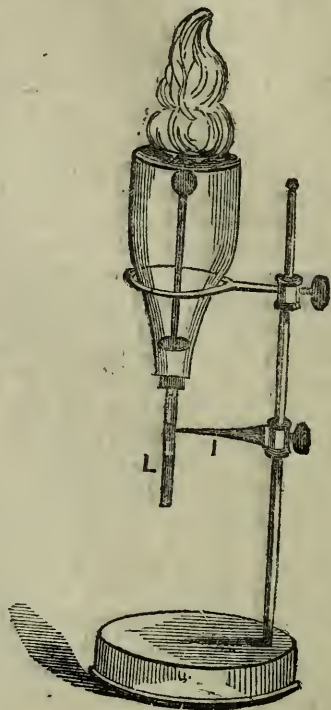


Fig. 65

in fig. 65, is filled nearly to the brim with water. A thermometer-tube, with a large ball, is so arranged in it that the ball is just covered, and no more, with the water; the stem passes out at the bottom through a tight cork and has a little coloured fluid, L, in it, which will of course move with any change of bulk in the air contained in the ball.

Thus arranged, a pointer, I, marks exactly the position of one of the drops of inclosed fluid, and a little ether is poured on the surface of the water, and set on fire. The flame is intensely hot, and rests on the surface of the water; the column of fluid at I is, however, unmoved, which would not be the case if any sensible quantity of heat had been imparted to the water. The warmth

of the hand touching the ball will at once move the fluid at I, by expanding the air within. By heating a vessel of water on the top, then, we should never succeed in creating anything more than a superficial boiling; at the depth of a few inches the water would remain cold.

The conducting power of gases is also very small. Heat travels with extreme slowness through a confined portion of air. This is a very different thing from the convection of heat in gases, which we will presently explain. Double windows and doors, and furring so called, of plastered walls, afford excellent illustrations of the slow conduction of heat through confined air. We have no proof that heat can be conducted in any degree by gases and vapours. To illustrate the relative conducting power of solids, fluids, and gases; if we touch a rod of metal heated to 120° , we shall be severely burned; water at 150° will not scald us if we keep the hand still, and the heat is gradually raised; while air at 300° has been often endured without injury. The oven-girls of Germany, clad in thick socks of woollen, to protect the feet, enter ovens without inconvenience where all kinds of culinary operations are going on, at a temperature above 300° ; although the touch of any metallic article while there, would severely burn them.

Convection of Heat.—Fluids and gases are heated by what is termed Convection. Heat applied from beneath to a vessel containing water, heats the layer or film of particles in contact with the vessel. These expand with the heat, and consequently, becoming lighter, rise, and colder particles supply their place, which also rise in turn, and so the whole contents of the vessel come successively into contact with the source of heat, and convey it away. This is well illustrated in fig. 66,

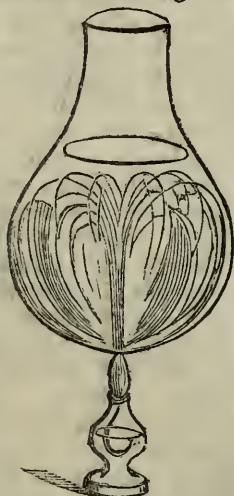


Fig. 66.

which shows how water acts in a vessel of glass, when heated at a point beneath by a spirit-lamp. Each particle in turn comes under the influence of heat, because of the perfect mobility of the fluid, and the heat is thus conveyed to, and distributed throughout, the whole mass. A series of such currents exist in every vessel in which water is boiled, and they are rendered more evident, by throwing into it a few grains of some solid (like amber), so nearly of the same gravity of water, that it will rise and fall with the currents. A perpetual circulation is thus established in fluids, which serves to keep up the equilibrium of temperature in our globe.

In the air, and in all gases and vapours, the same thing happens. The earth is heated by the sun's rays, and the film of air resting on the heated surface rises, or tends to rise, to be replaced by colder air. The rarified air may be easily seen on a hot day, rising from the surface of the earth, being made visible by its different refractive power. Hence arise many aerial currents and winds. The currents of the ocean are also influenced by the same cause.

Convection and conduction of heat will, therefore, be carefully distinguished from each other by the learner. Heat is, so to speak, transported rapidly in fluids by convection, while by conduction it travels slowly and progressively from particle to particle, within the limits of the body subject to it.

Radiant Heat.—We have spoken of the sun's rays as composed of both light and heat; these rays of heat proceed from all hot bodies, at all temperatures, for the slightest disturbance of the equilibrium of temperature will occasion their emission. Radiant heat is subject in all respects to the same laws, and possesses the same habitudes as light. It can pass through many substances; it is subject to reflection, absorption, refraction, and polarization. Radiation of heat takes place in a vacuum much more rapidly than in air, and is, therefore, quite independent of any conducting medium.

Reflection of heat is shown by the concave parabolic mirror. All rays of heat or light falling on this form of metallic mirror are collected at F, the focus, and

a hot body placed in the focus will have its rays sent forth in parallel straight lines, as shown in fig. 67. A second and similar mirror may be so placed as to receive and collect in a focus all the rays proceeding from any body in the focus of the other, where they will become evident by their effect on the thermometer. If the hot body be a red-hot cannon-ball, and the mirrors are carefully adjusted, so as to be exactly opposite each other in the same line, the accumulation of heat in the focus of the second mirror is such, as to inflame dry tinder, or gunpowder, even at twenty feet distance. This arrangement is shown in fig. 68, and the experi-

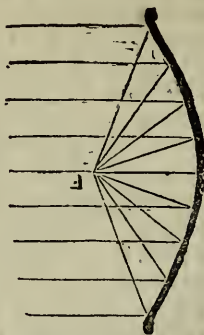


Fig. 67.

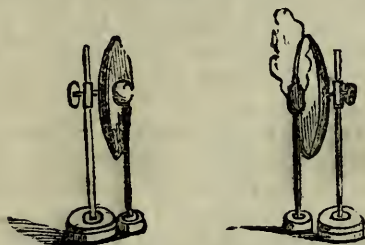


Fig. 68.

ment is a most striking and satisfactory one. It is quite essential that the mirrors should be highly polished; otherwise the heat, in place of being reflected to the second mirror, will be absorbed by the dull surface. A bright mirror will not become sensibly hotter from the near approach of the hot body, nearly the whole heat being reflected; but a black mirror will grow rapidly hot, and will then emit heat itself, by what has been called secondary radiation.

The formation of dew is owing to radiation, cooling the surface of the earth so rapidly, that the moisture of the air, which is always abundant in summer, is condensed upon it; as we see it on the outside of a tumbler of iced-water in a hot day. Radiation takes place more rapidly from the surface of grass and vegetation, than from dry stones or dusty

roads: for this reason, plants receive abundant dew, while the barren sand has none.

Radiation of cold was formerly supposed to occur, because a mass of ice placed in the focus of one mirror, caused the thermometer in the other to fall. The true explanation of this is, that the thermometer, in this case, is the hot body, and parts with heat to melt the ice, and thus restore the equilibrium of temperature. Cold is merely the absence of heat, and is a negative, and not a positive quality.

Absorption of Heat.—All black and dull surfaces absorb heat very rapidly when exposed to its action, and part with it again by secondary radiation. The sun shining on a person dressed in black, is felt with much more power than if he were dressed in white. The former colour rapidly absorbs heat, while from the latter a considerable part of it is reflected. The colour of bodies has nothing to do with their radiating powers, and one coloured cloth is as warm in winter as another, as regards the emission of heat.

The nature of the surface of bodies has the greatest effect on their several powers of radiation. Hot water in a bright tin canister, or a polished silver teapot, will remain hot very much longer than in a vessel with dull or roughened surfaces. A coating of lamp-black on the surface of a tin canister, placed in the focus of the mirror, will radiate five times more heat from boiling water than clean lead, and eight times more than bright tin, as proved by the differential thermometer. Bright metals have the lowest radiating power, and hence are selected to preserve heat in those substances which we wish to keep hot. For the same reason, they are the worst vessels in which to heat a fluid. The effort to boil water in a bright copper teakettle, is very tedious; as soon, however, as the surface becomes sooty from the fire, the heat passes in rapidly. The nature and not the colour of the surface affects radiation. A dull cast-iron stove radiates more heat than a polished sheet-iron one—the openness of the pores and great number of points of the cast-iron materially aid its radiating power.

SYSTEM OF ELOCUTION.

POSTURES AND MOTIONS OF THE HANDS.

THE Roman critics and orators attributed considerable importance to the manner of disposing the fingers, in delivery, ascribing to each particular disposition of them, a significance, or suitableness for certain expressions, of which we do not always see the force. Several of these dispositions of the fingers are employed by our speakers, but without attaching to them any particular significancy. Either they are natural gestures, or they are imitations, of which the origin is not remembered, or regarded, as many of our apparently original actions are.

The postures of the hand are determined by four different circumstances: 1. By the disposition of the fingers. 2. By the manner of presenting the palm. 3. By the combined disposition of both hands. 4. By the part of the body on which they are occasionally placed.

First Class of the Postures of the Hands, depending on the Disposition of the Fingers.

— *The natural state*, noted Fig. 7. The hand, when unconstrained, in its natural, and relaxed state, either hanging down at rest, or raised moderately up, has all the fingers a little bent inwards towards the palm; the middle and third finger lightly touch; the fore-finger is separated from the middle finger, and less bent, and the little finger separated from the third, and more bent. The extremity of the thumb bends a little outwards; and, in its general length and disposition, is nearly parallel with the fore-finger. When the arm is raised *horizontal*, the hand is held obliquely between the postures *inward* and *supine*. But it is not necessary that a speaker should confine himself to any one posture of the hand; variety may often demand the contrary: if, however, he should prefer using only one, this posture merits the preference.



Fig. 7.



Fig. 8.



Fig. 9.



Fig. 10.



Fig. 11.



Fig. 12.

Clenched, Fig. 8. The fingers, in this disposition, are firmly closed, and press their extremities upon the palm; the thumb aids the pressure, and is lapped, particularly over the middle finger.

Extended, Fig. 9. The fingers, in this state, whatever may be the general position of the hand, are separated from

each other with energy in proportion to the excitation of the speaker.

Index, Figs. 10, 11, 12. Pointing with the fore-finger, and sometimes also with the middle finger extended, the other fingers turned inwards, and contracted with more or less force, according to the energy of the speaker. This gesture is used in

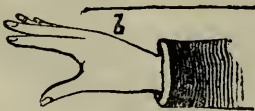


Fig. 13.



Fig. 14.



Fig. 15.



Fig. 16.

reproach and indication, from the last of which it has its name, *index*.

Collected, Fig. 13 and 14. When the ends of all the fingers are gently inclined towards, or touch the end of the thumb.

With the fingers collected, as in *a*, the hand is brought near the lips, or opposite shoulder, then removed in the contrary

direction, with the fingers extended, as in *b*.

Holding, Figs. 17, 18, 19. The finger and thumb are pressed together, either the fore or middle finger, or both; the other fingers are contracted, more or less,



Fig. 17.

according to the degree of energy required by the sentiment.

Hollow, Fig. 20. When the palm is



Fig. 18.



Fig. 19.

held nearly supine, and the fingers turn inwards, without touching.

Thumb, Fig. 21 and 22. Pointing



Fig. 20.



Fig. 21.



Fig. 22.

with the thumb, the fingers being clasped down, and the thumb extended.

Grasping, Fig.

23. The fingers and thumb seizing the garments, or the hair.

"That gesture," says Quintilian, "which urges on the words, contracting and opening the hand with alternate and rapid motion, is rather ad-

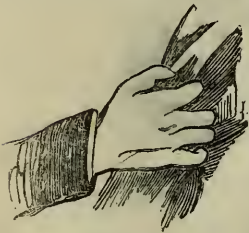


Fig. 23.



Fig. 24.

mitted by common usage, than according to art." (See Fig. 24.)

Second Class of the Postures of the Hands, depending on the manner of presenting the Palm. — *Prone*, Fig. 25. The hand is



Fig. 25.



Fig. 26.

prone when the palm is turned downwards.

Supine. The hand is said to be supine, when the palm is turned upwards, as in Fig. 26.

Inwards, Fig. 27. When the palm is



Fig. 27.

Fig. 28.

turned towards the breast and the hand is held on the edge.

Outwards, Fig. 28. When the palm is turned from the body, and towards the object, the thumb downwards, the hand held on the edge.



Fig. 29.

Vertical, Fig. 29. When the palm is perpendicular to the horizon, the fingers pointing upwards.

Forwards. When the palm is presented forwards, the arm hanging down, or placed in one of the extended, or

backward positions.

Backwards. When the palm is turned backwards, the arm hanging down, or placed in one of the extended, or backward positions.

Third Class of the Postures of the Hands, arising from the combined disposition of both

Hands. — Applied, Fig. 30. When the palms are pressed together, and the fingers and thumbs of each are mutually laid against each other.



Fig. 30.

Clasped, Fig. 31. When all the fingers are inserted between each other, and the hands pressed closely together.



Fig. 31.



Fig. 32.

Folded, Fig. 32. When the fingers of the right hand, at the second joint, are laid between the thumb and fore-finger of the left, the right thumb crossing the left.



Fig. 33.



Fig. 34.

Crossed, Fig. 33. When the left hand is placed on the breast, and the right on left, or the contrary.

at the middle joint of one hand, moderately bent, are received within the palm of the other, the fingers of which stretch along the back of the inclosed hand nearly

Inclosed, Fig. 34. When the knuckles



Fig. 35



Fig. 36.

to the wrist, the thumbs crossing, or rather, laid at length over each other.

Touching, Fig. 35. When the points of the fingers of each hand are brought lightly into contact.

Wringing, Fig. 36. When both hands are first clasped together, and elevated, then depressed, and separated at the wrists, without disengaging the fingers.

Enumerating, Fig. 37. When the index finger of the right hand is laid successively upon the index, or the different fingers of the left. If the number of divisions be more than four, the enumeration should begin from the thumb. Sometimes

the finger and thumb of the right hand

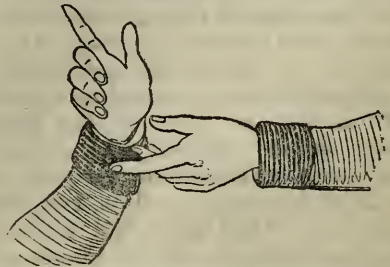


Fig. 37.

hold the finger of the left, which represent the division

THE GOLDEN PEACOCK.

PART III.

MOORED in a lonely bay, on the eastern coast of Britain, lay two Saxon vessels, waiting to take off Cerdic and Mordred and a small party of soldiers and priests of the Saxon idolatry, when they could get down to the coast without falling into the hands of the British, whom Arthur had instructed how to watch almost every possible path of escape. Near to this tranquil little bay stood a humble Christian church, built of wood, in plain and simple style—a house of God, indeed, rather than a temple of priests. In this little church the poor people of the surrounding rural district had been wont to worship in peace and humility. But Cerdic and his Saxons came when the people were at their prayers, and made all prisoners, except one, who escaped to spread the direful news, which soon reached the ears of King Arthur. He set out at once with a small party of men-at-arms, and marching rapidly through the night some twenty miles, surrounded the church before daybreak. Commanding perfect stillness among his soldiers, Arthur climbed into an oak-tree, which grew up before the church window, and from this elevation he commanded a clear view of all that was going on within. Part of the roof had been taken off for fear of the magical influences which the Saxon priests supposed the Britons to possess in covered buildings. A great image of Odin had been placed on the communion-table, and chained before it were the British prisoners. Children were there, weeping and wailing, shepherds, woodmen, artificers, and aged men and women; a little apart from them was the humble Christian priest of the little flock; and by his side stood Guinever, the captive Queen, pressing to her bosom a crucifix, her lovely countenance firm and composed.

To drown the cries of the captives, Saxon priests chanted wild rhymes in loud tones, with frenzied gestures. The spirits of demons seemed to have entered into them. They brandished knives and daggers close to the face of Guinever and the Christian priest, and drew near to them a large bronze sacrificial bowl, by which Arthur knew that it was intended

to sacrifice the prisoners to Odin, the Saxon god of slaughter. Thrilled with horror, he hastily descended the tree, gave a few hurried orders to his men, and then again reascending, followed by several soldiers, stealthily climbed upon the broken roof, and dropped softly down into the interior of the church.

"As I hope to enter Valhalla," exclaimed Cerdic, "which none may enter but the courageous who shed much blood, and make precious offerings of human life, I would, to conquer Arthur, here sacrifice to Odin the nearest and dearest of my blood and family; but now, instead, I offer, to propitiate the deity, the Queen of my enemy himself—Seize her, priests, strike deep, and let her blood be sprinkled abroad, to atone for the disgraces I have suffered from her lord—advance I say, and strike!"

"That will I, fell pagan," exclaimed King Arthur,—one blow from whose good sword, Calibur, laid Cerdic prostrate and bleeding at the hero's feet, and the next moment Guinever had flown to his arms, and swooned with sudden joy. The church door was burst open from without, and the astonished Saxons were surrounded and overpowered, while the building resounded with shouts of "King Arthur! King Arthur!" Then were the bonds of the British prisoners removed, and with prayers of thankfulness and cries of joy, they were set at liberty. Little quarter was given to the Saxons; when Cerdic half raised himself to address Arthur in broken Celtic language.

"King," said he, "thou hast been reputed magnanimous; fame sometimes lies in her reports; but I will speak her sooth, if thou wilt give me leave to die on sea instead of land, for my race ever loved the sea, and I would seek Valhalla through the watery paths. Grant me this, I do implore thee, O, victorious British Emperor."

"On one condition I will," replied Arthur; "thou shalt reveal where Mordred, my traitor cousin, lies hid, and thou shalt swear, whether thou livest or diest, to trouble this land no more."

"King Arthur, the gods befriend thee! I will strive no more. As for thy cousin, he is in the land whence my people come."

"Swear by Odin, your god there, if thou livest after this day, never to set foot again on British ground!"

"I swear by Odin! O remove me, my Saxons,—I faint."

"Take him to your ships yonder," said Arthur to the Saxon priests,—“and look he keep his oath.”

A few weeks after, Arthur and Guinever were solemnly crowned in Caerleon (in Monmouthshire), then a beautiful Roman-British city. Many tributary chiefs were present, from the lesser states of Britain. After the ceremony, a grand military festival was held for passages of arms:

——“At Caerleon, he kept the Table Round, Most famous for the sports at Pentecost, From whence all knightly deeds and brave achievements sprung.”

There were jousts, dances, carols, and “great and beautiful repasts.” The banner of the Golden Peacock, the symbol of the order, floated high and broad over the sumptuous pavilion that was erected for the heroic fraternity of the Round Table. Each of the brothers-in-arms sat at the banquet, having his brow wreathed with oak and laurel; the hair turned back from the forehead to the crown of the head, and thence to the neck, so as to leave the face fully seen. Long moustaches partly covered the mouth. The helmet, the lance, and the sword of each hero, was borne by a military vassal, who stood behind his lord’s seat. The helmet was of brass, surmounted by the Golden Peacock. At the banquet the warriors wore a dress not much unlike that which is now styled “the garb of old Gaul.” This was ornamented with bands of solid gold, worn about the neck and arms. Rings, also, they wore, and corslets of gold on the breast.

Guinever and her ladies graced the royal table, day by day, and applauded and rewarded the feats of arms. But the coronation festival took place at Pentecost, and on the following Midsummer-day, Guinever died, from the effects of her sufferings and alarm whilst Cerdic’s prisoner. Midsummer-day was a great festival among the British people, and Guinever had always favoured the old observances. The weather was warm, the sky clear and blue,—she lay and listened to the song of the lark, as it hovered

between heaven and earth, just visible through her open lattice, which let in a stream of sunshine on her couch. That lark was like an angel to Guinever. Her soul went up heavenward with its exquisite song, her constant affections dwelling to the last on Arthur. She chose her resting-place, a fair woodland scene. She pointed out the spot for her grave, under a verdant bank, o’ershadowed with trees:

——“Where the lark might make its nest,
And the breezes sweetly blow from the south
and from the west;

Where the pleasant flowers might bloom, and all
things seem so fair,

That even those in love with life might long to
rest them there.”

“There will I sleep,” she said, “until my lord King shall have finished the war; and then may he and I repose in the holy Abbey of Avalon.”

And her dying wishes were obeyed; and during many years, every Midsummer-day, a sort of floral festival was performed at her grave by British women, who loved and revered her memory. They came “With garlands wrought of motherwort, or else with vervain sweet;”

with orpine, called “Midsummer men,” with branches of green birch, and fair lilies and violets, and many other sweet forest flowers, that were left to breathe out their odorous existence in the tranquil solitude.

At that grave, Merlin and Arthur met,—the seer and king; and Arthur was reminded of the vision which Merlin had brought before him in Lindum Castle.

Merlin was attired in a blue flowing gown,—the symbolical colour of the Bardic Order of Druids,—and an upper robe, fastened on the shoulder with a massive gold button. He held a divining-rod, shaped like a shepherd’s crook. His head, bare and shining, was encircled by a wreath of oak-leaves, in honour of the Midsummer festival and the memory of Guinever. His beard black as night, covered his breast.

“King Arthur,” said he, “thou warrest in vain against the sons of Odin. As many Saxon kings as there are days in the week shall set up as many kingdoms, and the Celts and the Cymry must flee before them to the forests and the mountains; but the forests may not long afford them shelter, and in the mountains only

may they abide. I look, also, far away into distant time, and I see this Saxon race, mingled with other northern blood, forming one nation,—strong as the lion, soaring as the eagle, and clothed in riches and honour. Further still I look, and I see this matchless sea-born race, filling the whole earth with its language, its commerce, and its wisdom.”

“Have I then wasted the best years of my life in a fruitless struggle?” said Arthur; “that I never will believe!—No; I shall root out these faithless and perfidious Saxons; it is the work I was born to accomplish. I saw it before me, and accepted the charge when I was a boy at Tintagel. I would not lose my hopes of ultimate triumph for all that thou canst say. My father’s sword and shield shall not be laid by until my purpose is fulfilled, until I have driven these Saxon robbers back for ever to their native dens. I have no other hope or joy to live for now.”

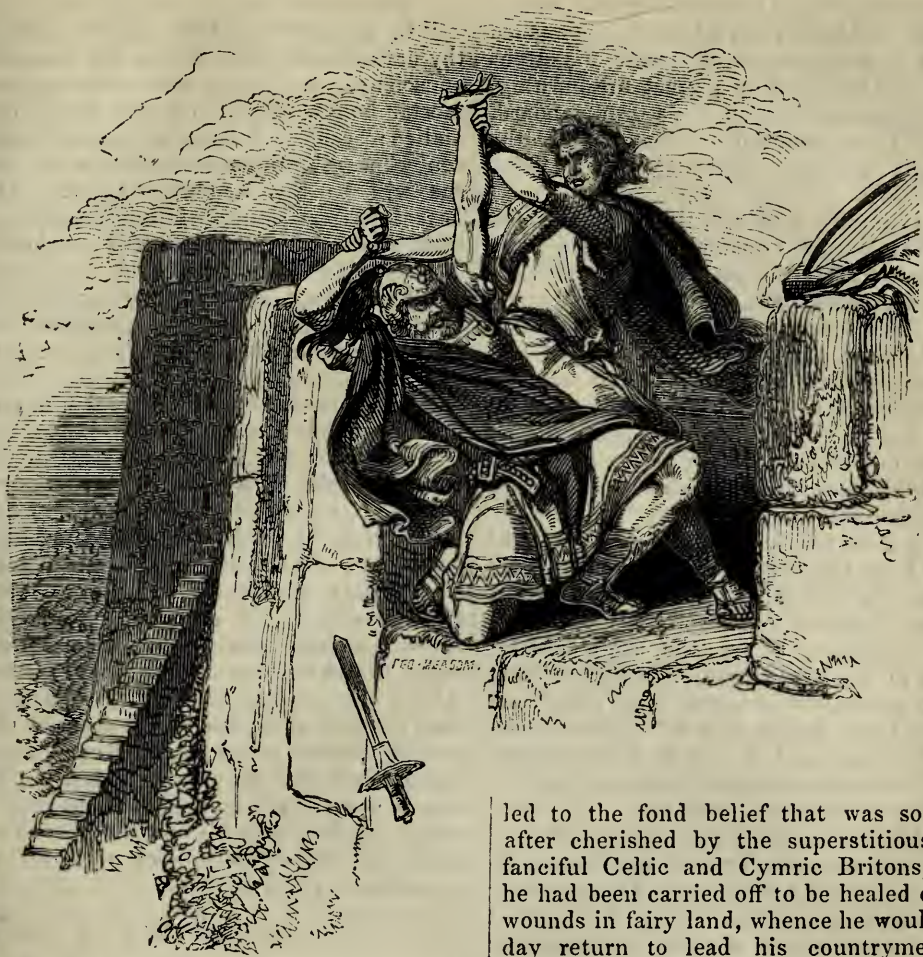
“King Arthur, ‘we see in part, and we know in part,’ but more remains unseen,—more remains unknown. Thou hast wrought great victories for the Celts and the Cymry, but their dominion is a tale that is told. Nevertheless, thy life is not wasted, for thy memory shall never cease from this land, and King Arthur and his Round Table shall be named as long as this island endures.”

“But what of Cerdic?”

“Once more thou shalt prevail against him; but if thou attempt further, thy sun will go down in blood. Then those other visions which I showed thee will become verity. Take thou warning—when the banner of the Peacock falls into the hands of the Saxons, king Arthur’s victories end.”

Cerdic slowly recovered of his wounds; then, breaking his engagement, he sailed round the island, and landed at Totness, in Devonshire. Arthur hastened, by forced marches, to punish this new aggression, and the Saxons were routed with immense slaughter at the grand battle of Badon (Bath), in which Arthur performed astonishing acts of valour, with his good sword *Calibur*, and his stout lance *Rou*. By this twelfth victory of king Arthur, Cerdic, a second time, was obliged to quit the country. But still he kept upon the open sea, watching for opportunities to renew his attempts.

The king of Strathelyde, Mordred’s brother, was faithful to the British cause, and, being besieged in his capital city, Alclwyd (Dumbarton), by the barbarian Scots, from the west and north, the heathen Picts and Saxons newly landed in the west, Arthur hastened with all speed to Alclwyd, defeated the barbarians, and pursued them into the fastnesses of Loch Lomond. The Pictish kingdom was divided into two hostile provinces,—the Christian and Pagan; the former, for the most part, dwelling south of the Grampians, the latter on the north. Brude, the father of Guinever, was the Christian king of the Christian Picts, who assisted Arthur with all the aid they could spare from the protection of their own homesteads. After the defeat of the heathen Picts and Scots, Brude returned with the British king, and as they moved southward, they carefully destroyed every Pagan temple, and restored the ruined churches. This was the period of the highest chivalric glory of King Arthur and his Round Table; for although, as an institution, chivalry and the feudal system date their commencement from a much later period, the romantic spirit of that institution, and, also, some of its essential forms, really originated with Arthur, whom we may style the morning star of chivalry. After the victory of Mount Badon, he divided the lands of Britain among his faithful vassals of the Round Table, they holding their respective territories on the condition of certain military aid to be rendered to Arthur and the commonwealth, whenever required. The object of this primitive feudal arrangement was simply defence of the country. The Round Table, therefore, was no mere splendid folly, such as the Round Table of King Edward III., imitated at Windsor from the traditions of Arthur, between seven and eight hundred years later. At the same time the lively imagination of Arthur delighted to invest with ideal symbols and poetic visions the stern and terrible reality of the great struggle on which he had embarked all his energies and all his hopes. The Bardic order of the Druids found in him a magnificent patron, and wherever he moved they attended his steps, ready to pour forth at his table metrical narratives of his battles and victories, songs of triumph, or lament



ing elegies. The harp, the voice, the inspired fancy, were never wanting, and no hero of the Round Table fell in battle unsung, nor was any deed of honour done for the British cause without being recorded in Bardic verse. Truth and poetry mingled in their compositions. It is worthy of remark, that in the most ancient specimens now existing of British poetry, the Triads, the poems of Llywarch Hen, and of Taliessin, speak of Arthur, not as the fabulous prodigy described by later romancers, but as a prince and captain of eminence. In the real life of Arthur, there is a period of no less than twenty to twenty-two years unaccounted for, from 520 or 522 to 542. This mysterious disappearance of the great chief

led to the fond belief that was so long after cherished by the superstitious and fanciful Celtic and Cymric Britons, that he had been carried off to be healed of his wounds in fairy land, whence he would one day return to lead his countrymen to ultimate victory and dominion over all their enemies. Everything connected with his disappearance was shrouded in darkness,—let us lift the veil a little.

A third time Cerdic landed on the south coast, and Arthur met him with his full power, at Llongborth (literally, the haven of ships), supposed to be Portsmouth.

Towards the close of this battle, Arthur pursued the Saxons into the marshy ground bordering the seacoast opposite Vectis, or the Isle of Wight. Here his horse stumbled, and he was thrown violently forward. The marshy nature of the ground hindered his movements, and in a minute he was surrounded by a troop of Saxons, who would have slain him there, but that he cried out, "Hold, I am Arthur!" The exultation of the Saxons was

indescribable, as the news spread among them that Arthur was taken. As he was led away to the presence of Cerdic, his attention was attracted by a great fire burning, in the midst of which was a torn standard.

"What standard is that which the Saxons are burning yonder?" asked Arthur.

"It is thy standard, the banner of the Golden Peacock," answered his guard; "we know that Merlin enchanted it, and when it is destroyed, your victories cease."

"Once more, then, we meet, king Arthur," said Cerdic, grimly smiling, "and under different auspices. Thou art my prisoner now!"

"And I ask no mercy, Saxon! At least I would not stain my name with falsehood to save my life,—so following thy example."

"For that saying would I slay thee, but that I owe thee requital for thy mercy, when I was in thy hands as now thou art in mine. Some of my vassals call Mordred, my lieutenant, hither; he shall conduct thee to the island yonder, and there shalt thou remain my prisoner until thou consent to the Saxon rule in Britain. Once yield in that, and I will give thee liberty and honourable place amongst us,—for thou art valiant and worthy."

"If thou or thy people hold one foot of the land of my fathers, it shall never be said that Arthur consented. Thy sword, or thy dungeon, rather than that. But one favour I claim of thee, in return for that I granted thee; make some other man than Mordred my keeper. There are wounds worse than the sword can give. Spare me the presence of this traitor, this apostate, this vile, perfidious ingrate!"

"Railing cannot set you free," said Mordred, as he approached exultingly.

"Nor move thy heart or conscience, villain!"

"Neither; you have wronged me from first to last, kept me down, supplanted me in everything I most desired. I united with the Saxons to humble thee, to bring thee low, and the hour has come. Thy power and dominion now are passed from thee for ever!"

"To thee and Cerdic?"

"Even so, great son of Uther!"

"But I have power and dominion beyond your reach."

"Where?"

"In my firm soul, base traitor! There thy dark shadow cannot dim my peaceful conscience, my happy memories, my immortal hopes. Therefore may I defy the malice; besides, I have an angel in heaven who will minister comfort to me, but she will be thy accusing spirit. She hovers in everlasting brightness near me; what canst thou do to rob me of that joy?"

"Thou dreamest, Arthur!"

"You cannot bar me from my dreams. You cannot fetter my free thought. Go to, I have a life within that mocks at prisoners!"

"The time is come to prove this boast; the vessel waits for you."

Visitors to Carisbrook Castle, in the Isle of Wight, of the nineteenth century, gaze with no small wonder on the ruined keep, with its perilous flight of seventy-two steps; almost perpendicularly placed on the side of a great artificial mound, and its well in the centre of the interior, three hundred feet deep. The lowest story of the keep only is preserved. Above this, in the time of king Arthur and Cerdic, were two other stories; the roof of which formed a small open area, surrounded by low battlements. The upper story was a dungeon, having a single narrow aperture cut in the thick stone wall for the admission of light and air—one of those

"Loop-hole grates, where captives weep."

In this dungeon King Arthur suffered all the horrors of a lengthened and hopeless captivity, while the Saxons made good their hold of Britain, and Cerdic and Mordred together ruled the west. Happy seemed it now to the hero that Guinever slept in peace. That consideration half reconciled him at times to his mournful destiny.

Let us look upon him near the close of his long captivity. His years are still in their prime, but confinement and sorrow have bowed his once gigantic form, traced his countenance with wrinkles, and blanched his long hair and beard, which hangs in wild tangled masses about his neck and face. Clad in a soiled and torn robe, he ascends a short spiral flight of steps, and stands upon the open roof of his prison, breathing the fresh air from hill and flowery

dale, and dizzily gazing out on the picturesque scenery, above which the donjon tower is placed, at an elevation trying to a weak brain.

The Saxon King Cerdic, is there, and fiercely he greets his prisoner.

"Now, what sayest thou? Hast thou finally resolved?"

"I have."

"You still refuse to submit to Saxon dominion in Britain?"

"I do."

"Well, then, thus stands the matter betwixt us. Merlin and the Druid bards have by some magic discovered where you are; the Celtic chiefs are astir, and buzzing about my ears like a swarm of bees. They mean mischief, and Mordred, your cousin, urges me to have you put to death. I have long resisted his designs, for I had rather win thee to be my fellow in arms, than slay thee. But I must hesitate no longer. Choose, therefore, to die now, flung like a dog from these battlements, or to say, I submit to the Saxons!"

"Chief, you know my mind; I am immoveable."

"Take heed, for the men are at hand whom I have prepared to hurl thee down. One breath of mine upon this horn, and the next minute sees thee dead!"

Cerdic stood close to one of the battlements; his drawn sword was in one hand, his signal horn and the key of the donjon tower in the other. A thought flashed across the brain of the captive; with that thought his former prodigious strength seemed to return; he sprang suddenly upon Cerdic, grasped him forcibly, and hurled him headlong from the tower. The Saxon chief lay dead in the deep ditch below. Arthur seized the tower key, and the sword, and flung about him a mantle which the Saxon chief had thrown aside on the platform, and thus he quitted the tower, and passed the guards, favoured by the evening twilight.

When Mordred heard of the death of the Saxon chief, and the escape of Arthur, he collected a great army of Saxons, Picts, and Scots, and prepared to contest the kingdom with his cousin in open battle. Nor were his preparations made too soon, for Arthur sailed in a merchant vessel from the Isle of Wight to Britain or Brittany, in Gaul, and there set up his standard, to

which flocked numbers of brave chiefs with their dependents and allies. Warships were furnished by the Britons to convey his army over sea, and thus King Arthur landed once more in the south-west of his native land, and hastened to meet Mordred. The fatal battle of Camlan ensued, in the year 542, in which both were slain. The dead body of Arthur was conveyed by sea to the abbey of Avalon (Glastonbury), and there interred; and the remains of the fair Guinever were removed to repose by his side.

THE MONTHS.—MAY.

(Continued from page 270.)

THE shadows of night are now fast retiring, to give place to the reviving radiance of the sun, Nature has long been stirring, even before our eyes were opened we heard the twittering of the birds, and lowing kine. Hark!

"Nature's universal song
Echoes to the rising day."

We must shake off the sloth that would benumb our best intentions, and sally forth to inspect the beauties and wonders of May.

How sweetly perfumed is the morning air, 'tis delightful! and the majestic woods that toss their umbrageous billows on the brow of yon hills, look as though gilt, as the first rays of the morning sun alight on their quivering leaves:

"Beside the dewy border let me sit,
All in the freshness of the humid air;
There, in that hollow'd rock, grotesque and wild,
An ample chair, moss-lined, and over head
By flowering umbrage shaded; where the bee
Strays diligent, and with the extracted balm
Of fragrant woodbine loads his little thigh."

In this cool spot we will gaze on the landscape before us, listening to the woodland song, and admiring the garniture of the fields and gardens.

O'er our heads, the gold clusters of the common laburnum (*Cytisus laburnum*), and the Scotch laburnum (*C. Alpinus*), hang in graceful profusion, imparting their fragrance to the passing breeze, while their golden chains afford a pleasing variety and strong contrast to the other

colours near them, particularly the dark lilac, the guelder rose, and common laurel, which we have noticed before.

What a beautiful bed of the rose bay or rhododendrons, that is just beyond the rock-work! There is the laurel rose (*Rhododendron Ponticum*), which is found wild on the coasts of the Black Sea; the rusty-leaved rose bay (*R. ferrugineum*); the Daurian rhododendron (*R. Dauricum*); the hairy species (*R. hirsutum*); and the Nepaul species (*R. arboreum*), which looks so beautiful with its large branches of scarlet blossoms. If you shake the tree, showers of liquid honey will fall from its flowers.

Here is a curious bed of flowers, where nearly each species of the month has its representative. In yonder corner is the columbine (*Aquilegia vulgaris*), with its graceful flowers hanging in confusion around its stems; emblematic of folly; near it you observe the red valerian (*Centranthus rubra*), with its large clusters of delicate blossoms; the milk-wort (*Polygala vulgaris*); the nard valerian (*Valeriana Celtica*), which many persons regard as the spikenard of the ancients; the officinal valerian; the poet's narcissus; and the lilacs, which we also noticed last month; then there is a beautiful group of lobelias, at the right-hand part of the bed; the cardinal flower (*Lobelia cardinalis*) which is a native of Virginia, and looks so grand with its long slender leaves and spike blossoms; the white lobelia (*L. longiflora*), which is such a deadly poison; the fulgent lobelia (*L. fulgens*), from Mexico; the Chilian species (*L. tupa*); and the shiny lobelia (*L. splendens*).

In wild confusion, yet lovely to gaze upon, are the blossoms of the other flowers, for their colours blend with a perfection scarcely to be expected from such a promiscuous assemblage. There you observe the broom (*Spartium scoparium*), and deadly nightshade (*Atropa belladonna*), both used as medicines; the syringa (*Philadelphus coronarius*); the star of Bethlehem (*Ornithogalum umbellatum*); the lungwort (*Pulmonaria officinalis*); the common reed of our climate (*Arundo phragmitis*), the garden persicaria (*Polygonum Orientale*), with its dark red spike of blossoms; the crimson geranium (*Geranium sanguineum*); and the yellow currant (*Ribes aureum*.)

If we stray towards yon rustic bower, we shall see many flowers that will be new to us, for there are

"Sweet roses and carnations gay,"

mingled with the spider wort (*Tradescantia Virginica*); the graceful calceolarius; the German flag (*Iris Germanica*); the rose acacia (*Robinia hispida rosea*), with its sprays of blushing flowers; the Charles's sceptre (*Pedicularis sceptrum Carolinum*) with its ruby-tipped golden flowers; and the yellow asphodel (*Asphodelus luteus*);

"No smiling knot

Of early primroses upon the warm,
Luxuriant, southern bank appears,"

but there are several species of monkshood with their dark blue flowers, especially the common variety (*Aconitum napellus*), with its deadly poison lurking in the sap-vessels of its leaves; the hairy wolfsbane (*A. barbatum*); the yellow monkshood (*A. anthora*), elegant, but poisonous; the great yellow aconite (*A. lycoctonum*), and the Indian species (*A. ferox*), which exceeds all the others in the virulence of its poison.

Do not the beautiful pink flowers of the Judas tree (*Cercis Siliquastrum*), with its large leaves, tempt you to stop and admire their admirable arrangement and exquisite form? and close by its side you observe

"The cumbrous bindweed, with its wreath and bells;"

the dark purple bells of the climbing cobæa (*Cobæa scandens*), and the trumpet honeysuckle (*Caprifolium sempervirens*.)

Cluster after cluster, and species after species of flowers, arise in quick succession, as we pass along the well gravelled paths, or evenly cropped lawn to inspect the formal beds, or lovely knolls. Pages! nay volumes, would not chronicle their names; and we must, therefore, hasten away, to take a peep at the wild flowers in yon lanes and meadows.

Here is a curious plant; 'tis the bee-orchis (*Ophrys apifera*), which looks so like an humble-bee, that you would almost fancy that there were several bees resting upon its stem. And here is the sweet woodruff (*Asperula odorata*) which is prized for its leaves, because it is said that when they are dried and mixed with snuff, they impart the same odour as the Tonquin bean.

There are several species of the genus *Orchis*, but perhaps it would be necessary to travel several miles in order to see them, and even then we might be disappointed, as some are natives of other climates, and not wild in ours. For example, there is the fly orchis (*O. muscifera*); the butterfly orchises (*Oncidium papilio*), and (*Habenaria bifolia*), two species which differ in appearance, the former simulating our tortoise-shell butterfly, and the latter much smaller and more fragrant; the early purple orchis (*O. mascula*); the marsh orchis (*O. latifolia*); the green-winged meadow orchis (*O. morio*); the spotted palmate orchis (*O. maculata*); and the little ladies, tresses (*Neottia spiralis*.)

The grasses are not less various than the flowers, and did space permit we might enumerate them all, but we may mention the common foxtail grass (*Alopecurus pratensis*); the annual meadow grass (*Poa annua*); the bulbous meadow grass (*P. bulbosa*); and the reed meadow grass (*P. aquatica*.)

The song birds that migrated last year to other climes, have returned to greet us once more with their melody:

"The aerial songsters soothe the listening groves,
The mellow thrush,* the ouzle,† sweetly shrill,
And little linnet,‡ celebrate their loves
In hawthorn valley, or on tufted hill;
The soaring lark,§ the lowly nightingale,||
A thorn her pillow, trills her doleful tale,
And melancholy music dies along the dale."

The redbreast (*Sylvia rubecula*), the delight of little children; the black-cap (*S. atricapilla*), which is one of the finest of our native songsters, and so well known for his loud and clear whistle; the garden fauvette or warbler (*Carruca hortensis*), so remarkable for the deep melody of its notes, its song being very little inferior to that of the nightingale; and the wren (*Anorthura communis*) with its sweet voice, are now in full song.

If we watch the arrival of the birds from southern latitudes, we shall notice the wood wren (*Sylvia sibilatrix*); the white-fronted redstart (*Motacilla phœnicurus*), with its plaintive note, issuing from some

ivied ruin, or branch of an old tree, for it delights to sing from a high perch; the cuckoo (*Cuculus canorus*), whose peculiar melodious notes charm its own species so much, that they often congregate in great numbers upon the same tree; the habillard, or white-breasted fauvette (*Carruca garrula*), whose low warbling song with its loud, inharmonious finish, is so often heard from the tops of lofty trees; the sedge babbler (*C. salicaria*), with its sparrow-like notes; the swift (*Cypselus murarius*), whose discordant screams as they pursue insects in flocks, have oft aroused the ire of many a love-sick swain; the red-backed shrike (*Lanius collurio*), those cruel birds that impale insects and young frogs upon the thorns of bushes, and devour them at their leisure, whence they are called "butcher-birds;" and the sand martins (*Hirundo riparia*), those unsociable little birds, that haunt the heaths, commons, and rude sequestered spots along the banks of rivers and old sand-pits, where, undisturbed by man, they burrow to a considerable depth, and deposit their four white eggs.

Let us ramble to the river's side, and,

"With line of silk, with hook of barbed steel,
Beneath this oaken umbrage let us lay,
And from the water's crystal bosom steal,
Upon the grassy bank, the finny prey:
The perch,* with purple speckles manifold;
The eel,† in silver labyrinth self-roll'd;
And carp,‡ all burnish'd o'er with drops of scaly gold."

The bleak (*Leuciscus alburnus*); the minnow (*L. phoxinus*); the chub (*L. cephalus*); and the bream (*Abramis brama*) are depositing their spawn among the gravelly beds of the rivers, and therefore we must not exercise our angling propensities among them.

The grassy banks, the moss-covered walls, the dank weeds at the margin of the ditches, the fields, lanes, hedges, and ponds, yes, and even the lichen-dotted stones, and half rotten trees, are eagerly explored by the entomologist, for now

"Is heard the hum

Of countless insects sporting on the wing,"

all starting into life and action, vivified by the genial warmth of the sun's increasing power.

* *Turdus musicus*. † Blackbird, *Turdus merula*
‡ *Fringilla cannabina*. § *Alauda arvensis*.
|| *Motacilla lusciniæ*.

* *Perca fluviatilis*. † *Anguilla communis*.
‡ *Cyprinus carpio*.

See the puss-moth (*Cerura vinula*), how pretty its grayish colour looks by the side of dark green leaves upon which it is resting for an instant; and there is the cinnabar moth (*Callimorpha Jacobæa*); the elephant-shining moth (*Deilephila Euphorbiæ*); the ghost moth (*Hepialus humuli*); and the goat moth (*Cossus ligniperda*).

There is scarcely a tree or shrub, and flower or weed, however small, that does not afford a shelter to some insect, either in its perfect state, or in its embryo form. Look at those crawling caterpillars, clothed with bristling hairs, and arrayed in a coat of many colours. Who would imagine that they will one day soar high above our heads? Yet such is the fact. The poet, Rogers, has addressed some beautiful lines to the butterfly, which are so appropriate, that we consider them worthy of a place in our columns:

THE BUTTERFLY.

Child of the Sun! pursue thy rapturous flight,
Mingling with her thou lov'st in fields of light;
And where the flowers of Paradise unfold,
Quaff fragrant nectar from their cups of gold.
There shall thy wings, rich as an evening sky,
Expand and shut with silent ecstasy!
Yet wert thou once a worm, a thing that crept
On the bare earth, then wrought a tomb and
slept!
And such is man,—soon from his cell of clay
To burst a seraph in the blaze of day!"

See how gaily the queen of Spain butterfly (*Argynnis Lathonia*) skims along the air, sporting in the solar beams; and there is the wood-lady butterfly (*Pontia Cardamines*); the common blue beetle (*Polyommatus Alexis*); and the cabbage butterfly (*Pontia brassicæ*).

Hark to the incessant hum or buzzing noise made by the cockchafer, May-beetle, or May-bug (*Melolontha vulgaris*), as it whirls past you from tree to tree; and if we search diligently we shall find the rosechafer (*Cetonia aurata*); the whirlwig beetle (*Gyrinus natator*); the smooth Dor-beetle (*Geotrupes lævis*); the bombardier beetle (*Brachinus crepitans*); the burying beetle (*Necrophorus sepultor*); the golden fly (*Chrysus fulgida*); the two-spotted ladybird (*Coccinella 2-punctata*); the tortoiseshell ladybird (*C. dispar*); and the cuckoo-spit frog-hopper (*Aphrophora spumaria*).

The quadrupeds of the month are the mole (*Talpa Europæa*); which is so well-known for its subterranean life, and now

commences to extend its burrows; the hedge-hog (*Erinaceus Europæus*); frequently called "an urchin," which is common in the woods and hedges, venturing forth at night or eventide, when it hunts for cockchafers and other insects, and has even been known to attack toads and leverets; and last of all, the common brown rat (*Rattus decumanus*), which litters near the water, and is too well known to need any description.

The reptiles comprise the frog (*Rana temporaria*); the toad (*Bufo communis*); and the natterjack (*B. rubeta*), which are seen in the ponds in their first and second stages of transformation.

Let the young learn to walk early abroad, and view the changes of Nature. It expands the mind of the humblest child to study the wondrous works of God, but many turn aside

"From all these things, whereof He said,
When the great whole was finished,
That they were "very good!"

OF DELAYS. — Fortune is like the market where, many times, if you can stay a little, the price will fall; and again, it is sometimes like the Sibyl's offer, who at first offereth the commodity at full, then consumeth part and part, and still holdeth up the price. There is surely no greater wisdom than well to time the beginnings and onsets of things. Dangers are no more light if they once seem light: and more dangers have deceived men than forced them. Nay, it were better to meet some dangers half-way, though they come nothing near, than to keep too long a watch upon their approaches; for if a man watch too long, it is odds he will fall asleep. On the other side, to be deceived with too long shadows — as some have been, when the moon was low and shone on their enemies, and so to shoot off before the time—or to teach dangers to come on, by an over-early buckling towards them, is another extreme. The ripeness or unripeness of the occasion must ever well be weighed; and, generally, it is good to commit the beginnings of all great actions to Argus with his hundred eyes, and the ends to Briareus with his hundred hands; first to watch, and then to speed.—*Lord Bacon*.

NATURAL PHILOSOPHY.

THE LEVER.—CONTINUED.

LEVERS are used in practice for many different purposes. By their agency a small power may hold in equilibrio, or move a great weight: thus, the power of one man applied at the end of a crowbar will overturn a heavy mass, the man acting at a distance of several feet, and the mass at only a few inches from the fulcrum.

[Levers are sometimes compound, or made up of several simple levers connected together, so as to act one upon the other. For example, suppose we wish to have a very long lever, or one possessing great mechanical power, it is easier to arrange a series of levers, so that the power acting on the end of the first lever shall raise the second, and that, depressing the end of the third, will raise a weight at the further end. For example, suppose that we wished to balance 1,000 pounds by means of one pound, the distance of the power from the fulcrum must be 1,000 times that of the weight, and as this would be very inconvenient, we employ three levers for the purpose of obtaining the same result. The relative length of the arms of each lever is as ten to one; and if we examine Fig. 155, we shall see that the levers are so arranged as to

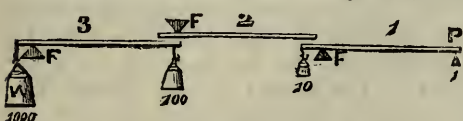


Fig. 155.

bear upon one another. Thus, the power of one pound will balance the weight of ten pounds; and as the weight end of the first lever is placed under the power end of the second lever, it will exercise a force of ten pounds upon it. The second lever being raised with a force of ten pounds, and having the same mechanical advantage as the first, will press down the weight end upon the power end of the third, with a force equal to 100 pounds. This force of 100 pounds, being applied to the power end of the third lever, will act upon the same principles as the others, and raise the weight end with a force of 1,000 pounds.

In calculating the action of any compound system of levers, it does not affect the principles of calculation if some of the levers are of the first kind, and some of any other. The rule, is to "multiply the weight on any lever by its distance from the fulcrum, and multiply the power by its distance from the same point; if the products are equal, then the weight and power will balance each other." If we wish to calculate the effect of the system given in Fig. 155, we must multiply the length of the long arm by the power, and multiply the short arm by the weight or resistance offered.

—W. T. K.]

For many of the purposes of science, levers are used to magnify small motions

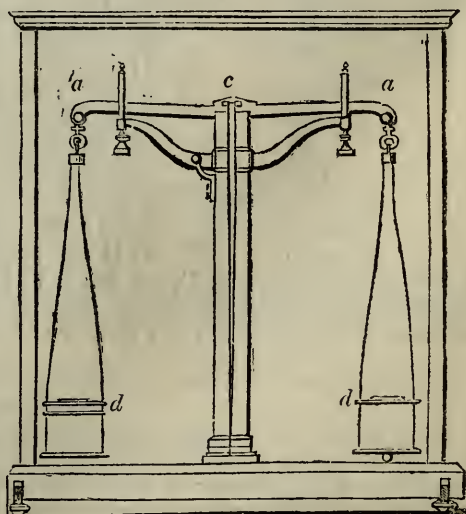


Fig. 156.

The power causing the motion is applied by a short arm near to the fulcrum of the lever, and the other arm which may be ten, twenty, or more times longer, moves over a graduated scale. The pyrometer is an example of this application.

The most accurate means for determining the weight of bodies is by the lever. When arranged for this purpose, it passes under the name of "The Balance." It is a lever of the first kind with equal arms. Various forms are given to it, and various contrivances annexed for the purpose of insuring its lightness, its inflexibility, and the absolute equality of the lengths of its arms. Fig. 156, represents one of the best kinds: *a a*, is the beam; *c* is the fulcrum, or centre of motion; *d d*, are the scale-pans in which the weights and objects to be weighed are applied; their points of suspension are at *a a*. With a view of reducing friction, the axis of motion, *c*, and both the points of suspension are knife-edges of hard steel working on planes of agate: and to preserve them uninjured, the beam and the scale pans are supported upon props, except at the time a substance is to be weighed. Then, by moving the handle, *f*, the axis of motion is deposited slowly on its agate plane, and the scale-pans on their points of suspension, and the beam thrown into action.

In balances it is essential that the centre of gravity should have a particular position. The cause of this will be appreciated from what has been said in Chapter XXIV. Thus, if the centre of gravity coincided with the centre of motion, the balance beam would not vibrate but would stand in a position of indifferent equilibrium, whatever angular position might be given to its arms.

If the centre of gravity was above the axis of motion, the balance would be in a condition of unstable equilibrium, and would overset by the slightest increase of weight on either side, the centre of gravity coming down to the lowest point. But when it is beneath the axis of motion, the balance vibrates like a pendulum, and neither sets nor oversets. It is essential, therefore that in all these instruments the centre of gravity

should be below the centre of motion. And it might be shown that the sensibility of the balance, or, in other words, the smallness of the weight it will detect, becomes greater as these two centres approach each other.

The different kinds of weighing-machines are either modified levers or combinations of levers. Examples occur in the machine for weighing loaded carts, in the steelyard, which is a lever of unequal arms, and in the bent lever balance. The latter is represented in Fig. 157. It consists of a bent lever, *A B C*, the end of which, *C* is loaded with a fixed weight. This lever works on a fulcrum, *B*, supported on a pillar, *H J*. From the arm, *A*, is suspended a scale-pan, *E*, and to the pillar there is affixed a divided scale, *F G*, over which the lever moves. Through *B* draw the horizontal line, *G K*, and let fall from it the perpendiculars, *A K*, *D C*. Then if *B K* and *B D* are inversely proportional to the weight in the scale,

E, and the fixed weight, *C*, the balance will be in equilibrio; but if they are not, then the lever moves, *C* going farther from the fulcrum, and stopping when equilibrium is attained. The scale, *F G*, is graduated by previously putting known weights in *E*.

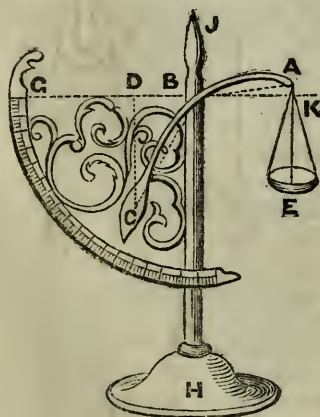


Fig. 157.

CHAPTER XXVIII.

THE PULLEY.—THE WHEEL AND AXLE.

Description of the Pulley.—Laws of the Lever apply to it.—Use of the Fixed Pulley.—The Moveable Pulley.—Runners.—Systems of Pulleys.—White's Pulley.—Law of Equilibrium.—Advantages of the Wheel and Axle over the Lever.—Windlass.—Capstan.—Wheelwork.—Different kinds of Toothed Wheels.

THE pulley is a wheel, round the rim of which a groove is cut, in which a cord can

work, and the centre of which moves on pivots in a block. The wheel sometimes passes under the name of a sheave.

By a fixed pulley, we mean one which merely revolves on its axis, but does not change its place. The power is applied to one end of the cord and the weight to the other.

The action of the pulley may be readily understood from that of the lever. Let c , Fig. 158, be the axis of the pulley, b , the point to which the weight is attached; a the point of application of the power; draw the lines, $c b$, $c a$ —they represent the arms of a lever—and the law of the equilibrium of a lever, therefore, applies in this case also; and as these arms are necessarily equal to each other, the pulley will be in equilibrio when the weight and power are equal.

If the direction in which the power is applied, instead of being $P a$, is $P' a'$, the same reasoning holds good. For, on drawing $C a'$, as before, it is obvious that $b c a$ represent a bent lever of equal arms. The condition of equilibrium is, therefore, the same.

The fixed pulley does not increase the power, but it renders it more available, by permitting us to apply it in any desired direction.

To prove the properties of the pulley experimentally, hang to the ends of its cord equal weights; they will remain in equilibrio. Or, if the power be increased, so as to make the weight ascend, the vertical distances passed over are equal.

The moveable pulley is represented at Fig. 159. Its peculiarity is that, besides the motion on its own axis, it also has a progressive one. Let b be the axis of the pulley, and to it the weight, W , is attached, the power is applied at a . Draw the diameter, $a c$, then c is the fulcrum of $a c$, which is in reality a lever of the third order in which the distance, $a c$, of the power is twice that, $b c$, of the weight. Consequently "the moveable pulley doubles the effect of the power," and the distance traversed by the power is twice that traversed by the weight.

A moveable pulley is sometimes called "a runner;" and as it would be often inconvenient to apply the in the upward direction, as at $a P$, there is commonly associated with the runner a fixed pulley, which without changing the value of the power, enables us to vary the direction of its action.

Systems of pulleys are arrangements of sheaves, moveable and fixed.

When one fixed pulley acts on a number of moveable ones, equilibrium is maintained, when the power and weight are to each other as 1 to that power of 2 which equals the number of the moveable pulleys. Thus, if there be, as in Fig. 160, three moveable pulleys, the power is to the weight as $1 : 2^3$ that is $1 : 8$; consequently, on such a system, a given power will

support an eightfold weight.

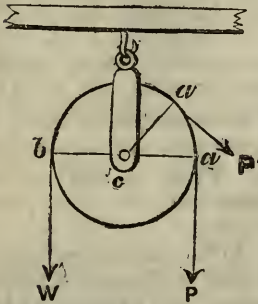


Fig. 158.

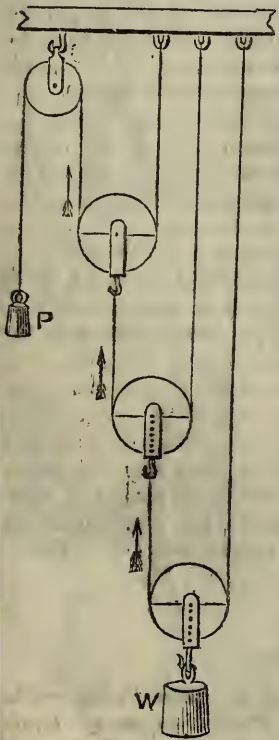


Fig. 160.

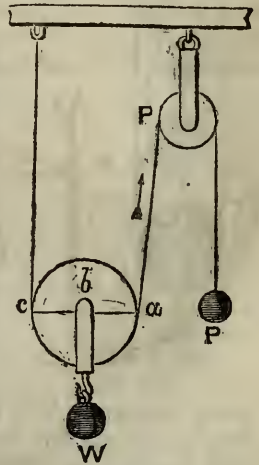


Fig. 159.

When several moveable and fixed pulleys are employed, as in Fig. 161, equilibrium is obtained when the power equals the weight divided by twice the number of moveable pulleys. The weight being equally divided between the six lines, it follows that each is drawn by $\frac{1}{6}$ th of the weight, W . Consequently, if sixty pounds weight is suspended to the bottom, each line would be drawn upon by a force of ten pounds. If we wish to keep this machine in a state of equilibrium, we must attach a weight, P , of ten pounds to the end of the line.

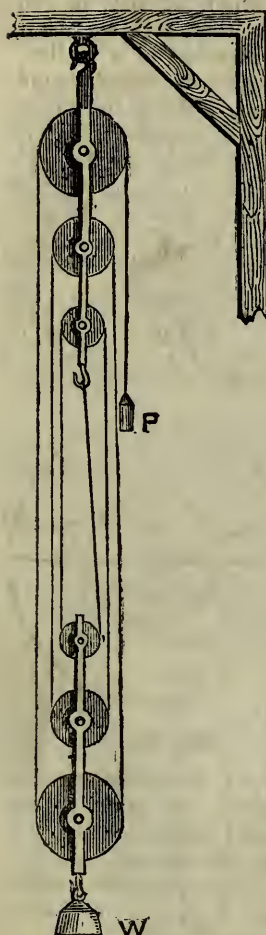


Fig. 161.

In such systems of pulleys there is a great loss of power arising from the friction of the sheaves against the sides of the blocks, and on their axles. In White's pulley this is, to a considerable extent, avoided. This contrivance is represented in Fig. 162. It consists of several sheaves of unequal diameters, all turned on one common mass, and working on one common axis. The diameters of these, in the upper blocks, are as the numbers 2, 4, 6, &c., and in the lower 1, 3, 5, &c.; consequently, they all revolve in equal times and the rope passes without sliding or scraping upon the grooves.

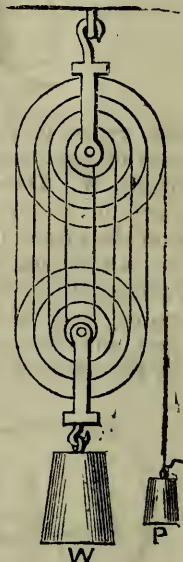


Fig. 162.

THE WHEEL AND AXLE.

The wheel and axle consists of a cylinder revolving upon an axis, and having a wheel of larger diameter immoveably affixed to it. The power is applied to the circumference of the wheel, the weight to that of the axle.

[Let $a b$, be a wheel, $c d$, Fig. 163, its axle, and suppose the circumference of the wheel to be eight times as great as the circumference of the axle; then a power, P , equal to one pound, hanging by the cord, I , which goes round the wheel, will balance a weight, W , of eight pounds, hanging by the rope, K , which goes round the axle; and as the friction on the pivots, $E F$, or gudgeons of the axle is but small, a small addition to the

power will cause it to descend, and raise the weight; but the weight will rise with only an eighth part of the velocity where-with the power descends, and consequently, through no more than an eighth part of an equal space, in the same time. If the wheel be pulled round by the handles, $S S$, the power will be increased in proportion to their length. G , is a ratchet-wheel on one end of the axle, with a catch, H , to fall in its teeth.—*Ferguson's Lectures*, 10th Edition, p. 55.]

The law of equilibrium is, that "the power must be to the weight as the radius of the axle is to that of the wheel."

This instrument is, evidently, nothing but a modification of the lever; it may be regarded as a continuously acting lever, in fact, it is sometimes called "the perpetual lever." In its mode of action, the common lever operates in an intermitting way, and, as it were, by small steps at a time. A mass which is forced up by a lever a short distance, must be temporarily propped, and the lever re-adjusted before it can be brought into action again; but the wheel and axle continues its operation constantly in the same direction.

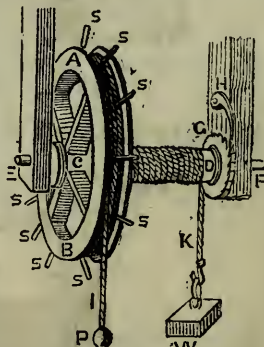


Fig. 163.

[The inconvenience of having a large wheel and very slender axle may be avoided, without lessening the mechanical advantage, by employing a machine called the "Chinese wheel and axle," which consists of two cylinders, one larger than the other, turning about the same axis. The weight is attached to a pulley, which plays on a long cord, which is coiled round both axles in contrary directions. When the winch is turned, one end of the cord uncoils from the smaller cylinder, and is wound round the larger; thus the weight is elevated at each turn, through a space equal to half of the difference between the circumference of the two cylinders. Therefore the advantage of this machine, with its pulley, is in the ratio of the diameter of the larger cylinder, to half its excess above that of the lesser one.—W. T. K.] (Fig. 164.)

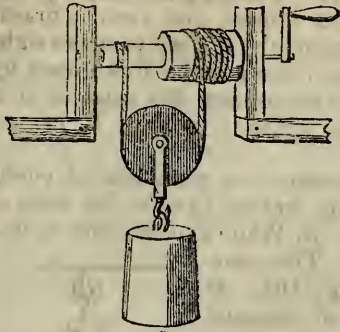


Fig. 164.

That this is its mode of action may be understood from considering Fig. 165, in which let c be the common centre of the axle, $c b$, and of the wheel, $c a$, a the point of application of the power, P , and b that of the weight, W . Draw the line $a c b$; it evidently represents a lever of the first order, of which the fulcrum is c , and from the principles of the lever, it is easy to demonstrate the law of equilibrium of this machine, as just given. Further, it is immaterial in what direction the power be applied, as P' at the point, a' for $a' c b$ still forms a bent lever, and the same principle still holds good.

[The effect of the wheel depends upon the superiority

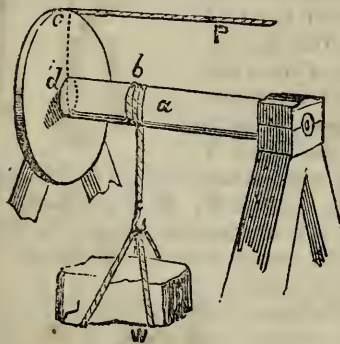


Fig. 166.

of the radius, or diameter of the wheel, to that of the axle. In Fig. 166, we see that the weight, W , corresponds to the counteracting force, P , in an inverse ratio to the arms of the lever; that is, inversely to the radii, $a b$, and $d c$, of the wheel. Let us suppose that the radius, $a b$, of the axle, is four times less than the radius, $d c$, of the wheel, we may equipoise a weight of eighty pounds by a force of twenty pounds.—W. T. K.]

Sometimes the wheel is replaced by a winch, as in Fig. 167; it is then called a "windlass," if the motion is vertical; but if it be horizontal, as in Fig. 168, the machine is called a "capstan," which differs from the windlass in having its revolving axis

placed vertically. The circumference is pierced with holes which receive long levers,

Fig. 165.

placed vertically. The circumference is pierced with holes which receive long levers,

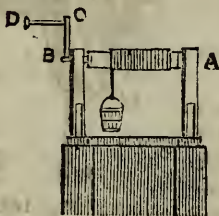


Fig. 167.



Fig. 168.

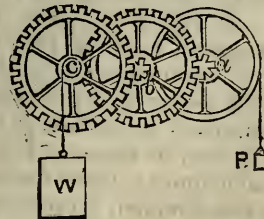


Fig. 169.

called capstan-bars, by which it is worked by men, who walk round the capstan, and make it revolve by pressing the ends of the levers forward.

[The tread-mill is another variety. In this case the weight of several people treading on the circumference of a long wheel causes it to revolve. The paddle-wheel of a steam-boat acts on the same principle; the water, which offers a resistance to the motion of the paddle-boards, is the power.—W. T. K.]

Wheels and axles are often made to act upon one another by the aid of cogs, as in clockwork and mill machinery. In these cases the cogs on the periphery of the wheel take the name of teeth, those on the axle the name of leaves, and the axle itself is called a pinion.

The law of equilibrium of such machines may be easily demonstrated to be, that the power multiplied by the product of the number of teeth, in all the wheels, is equal to the weight multiplied by the product of the number of leaves in all the pinions.

A system of wheel and pinion work is represented at Fig. 169. It is scarcely necessary to observe, that in it, as in all other cases, the law of virtual velocities holds good—the power multiplied by the velocity of the power is equal to the weight multiplied by the velocity of the weight.

In the construction of such machinery attention has to be paid to the form of the teeth, so that they may not scrape or jolt upon one another. Several of them should be in contact at once, to diminish the risk of fracture and the wear.

If the teeth of a wheel be in the direction of radii from its centre it is called a spur-wheel.

If the teeth are parallel to the axis of the wheel it is called a crown-wheel.

If the teeth are oblique to the axis of the wheel it is called a beveled-wheel.

By combining these different forms of wheel suitably together, the resulting motion can be transferred to any required plane. Thus, by a pair of beveled-wheels motion round a vertical axis may be transferred to a horizontal one, or, indeed, one in any other direction.

When a pinion is made to work on a toothed-bar, it constitutes a rack. This contrivance is under the same law as the wheel and axle.

CHAPTER XXIX.

THE INCLINED PLANE.—THE WEDGE.—THE SCREW.

Description of the Inclined Plane.—Modes of applying the Power.—Conditions of Equilibrium when the Power is Parallel to the Plane or Parallel to the Base.—Position of Greatest Advantage.—Description and Mode of using the Wedge.—Formation of the Screw.

By the inclined plane we mean an unyielding plane surface inclined obliquely to the resistance to be overcome.

In Fig. 170, A C represents the inclined plane; the angle at A is the elevation of the plane; the line A C is the length, C B is the height, A B the base.

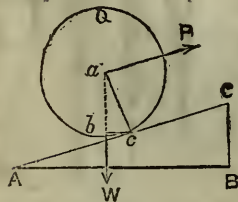


Fig. 170.

In the inclined plane the power may be applied in the following direction:—1. Parallel to the plane; 2. Parallel to its base; 3. Parallel to neither of these lines.

As in the former cases, so in this—the conditions of the equilibrium may be deduced from those of the lever.

Let us take the first instance, when the power is applied parallel to the inclined plane. Let Q, Fig. 170, be a body placed upon the plane, A C, the height of which is B C, and the base A B. The weight of this body acts in the vertical direction, $a W$; the body rests on the point, c , as on a fulcrum; and the power, P , under the supposition, acts on Q, in the direction $a P$. From the fulcrum, c , draw the perpendicular, $c b$, to the line of direction of the weight, $a W$; draw also $c a$. Then

does bca represent a bent lever, the power being applied to the point a , and the weight at the point b ; and, therefore, the power is to the weight as bc is to ac ; but the triangles, abc , ABC , are similar to each other. Therefore, we arrive at the following law:

When the power acts in a direction parallel to the inclined plane, it will be in equilibrium with the weight when it is to the weight as the perpendicular of the plane is to its length.

In a similar manner it may be shown that when the power acts parallel to the base it will be in equilibrium with the weight, if it be to the weight as the perpendicular of the plane is to its base.

In different inclined planes the power increases as the height of the plane, compared with its length, diminishes, and the best direction of action is parallel to the inclined plane. This is very evident from the consideration that if the power be directed above the plane a portion of it is expended in lifting the weight off the plane, while the diminished residue draws it up. If it be directed downward a part is expended in pressing the weight upon the plane, and the diminished residue draws it up. Therefore, if the power acts parallel to the plane, it operates under the most advantageous condition.

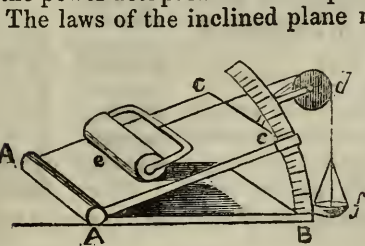


Fig. 171.

The laws of the inclined plane may be illustrated by an instrument, such as is represented in Fig. 171, in which $AcA'c'$ is the plane, which may be set at any angle. It works upon an axis, AA' . Upon the plane a roller, e , moves. It has a string passing over a pulley, d , and terminating in a scale-pan, f , in which weights may be placed. The direction of the string may be varied, so as to be parallel to the plane, or the base, or any other direction.

The inclined plane is used for a variety of purposes—very frequently for facilitating the move-

ments of heavy loads.

THE WEDGE.

The wedge may be regarded as two inclined planes laid base to base— BDA , Fig. 172, being one, and BCA being the other. The planes, CA and DA constitute the sides or faces of the wedge; B is its back, and BA its length.

The mode of employing the wedge is not by the agency of pressure, but of percussion. Its edge being inserted into a fissure, the wedge, as in Fig. 173, is driven in by blows upon its back. After it has been struck for some time, the wedge enters further into the substance of the wood, as in

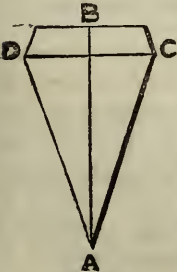


Fig. 172.

Fig. 174, and when the wood cannot be compressed any more, the wedge splits it, as in Fig. 175. It is kept from recoiling by the friction of its sides against the surfaces past which it has been forced.

This mode of application of the wedge prevents us from comparing its theory with that of the inclined plane—a power to which it has so much external resemblance.

The power of the wedge increases as the length of its back, compared with that of its sides, is diminished. As instances of its application, we may mention the splitting



Fig. 175.

Fig. 174.

Fig. 173.

of timber, the raising of heavy weights, such as ships. Different cutting instruments, as chisels, &c., act in consequence of their wedge-shaped form.

THE SCREW.

If we take a piece of paper cut into a long, right-angled triangle, Fig. 176, and wind it about a cylinder, Fig. 177, so that the height, *CB*, of the triangle is parallel to the axis, the length, *AC*, will trace a screw-line on the surface. The same results if we take a cylinder and wind upon it a flexible cord, so that the strands of the cord uniformly touch one another.

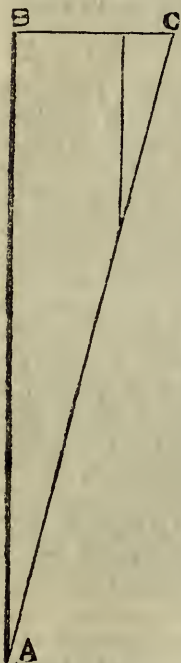


Fig. 176.

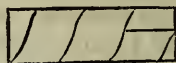


Fig. 177.

In any screw, the line which is thus traced upon the cylinder goes under the name of the "worm," or "thread," and each complete turn that it makes is called a "spire." The distance from one thread to another, which, of course, must be perfectly uniform throughout the screw, is called the breadth of the worm.

[The thread of a screw may have a thin sharp edge, as in Fig. 178, or a square edge as in Fig. 179. In either case the principle of its action is the same.—W. T. K.]

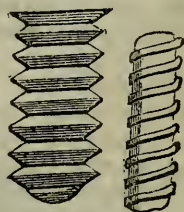


Fig. 178. Fig. 179.

In most cases the screw requires a corresponding cavity in which it may work; this passes under the name of a "nut." Sometimes the nut is caused to move upon the screw, and sometimes the screw in the nut. In either case the moveable part requires a lever to be attached, to the end of which the power is applied.

The law of equilibrium of the screw is, that "the power is to the weight as the breadth of the worm is to the circumference described by that point of the lever to which the power is attached."

When the end of the screw is advancing through a nut, this law evidently becomes that the power is to the weight as the circumference described by the power is to the space through which the end of the screw advances. It is obvious, therefore, that the force of

the screw increases as its threads are finer, and as the lever by which it is urged is longer.

USE THE MINUTES.—It is asked, says Channing, how can the labouring man find time for self-culture? I answer that an earnest purpose finds time, or makes time. It seizes on spare moments, and turns fragments to golden account. A man who follows his calling with industry and spirit, and uses his earnings economically, will always have some portion of the day at command. And it is astonishing how fruitful of improvement a short season becomes, when eagerly seized and faithfully used. It has often been observed that those who have the most time at their disposal, profit by it the least. A single hour in the day, steadily given to the study of some interesting subject, brings unexpected accumulations of knowledge.

RUBENS AND THE LION.—It is related that Rubens caused a remarkably fine and powerful lion to be brought to his house, in order to study him in every variety of attitude. One day, Rubens, observing the lion yawn, was so pleased with this action that he wished to paint it, and he desired the keeper to tickle the animal under the chin, to make him repeatedly open his jaws; at length the lion became savage at this treatment, and cast such furious glances at his keeper, that Rubens attended to his warning, and had the lion removed. The keeper is said to have been torn to pieces by the lion shortly afterwards; apparently, he had never forgotten the affront. The authenticity of this anecdote is, however, questioned by some.

SYSTEM OF ELOCUTION.

GESTURE.

The Stroke and Time.—The arm, the fore-arm, the hand, and the fingers, form the grand instrument of gesture, or, as Cicero calls it, "the weapon of the orator." The centre of motion of this compound instrument, is the shoulder. These parts do not move together in the manner of an inflexible line; but each separate joint often becomes a new centre of motion for the portion between it and the extremity.

In gesticulating, this complex instrument does not continue long in one direct line, nor in any particular flexure, but changes every moment the angles formed at the different joints, which adds grace and variety to the motions. The farther any portion of this complex line is from the centre of motion, the greater space does it pass through. The least motion, therefore, is that made by the upper arm, and the greatest, that made by the hand; from this circumstance alone, the gestures of the latter are conspicuous. In gesticulating, the hand has not only the advantage of being placed at the extremity of the line farthest from the centre of motion; but by means of the joint at the wrist, it can spring with increased velocity on approaching the point to which its gesture is directed. This action of the hand is termed the *stroke* of the gesture; and it should be marked by different degrees of force, according to the energy of the sentiment. In high passion, it should be distinguished by a strong percussion; and in the more moderate state of the speaker's feelings, merely by a turn of the hand, by a change of posture, or elevation of the arm, or by a momentary arrest of the motion of the gesture in its transitions.

The stroke of the gesture is analogous to the emphasis of the voice; and they should both fall exactly on the accented syllable of the emphatic word. In this way the emphatic force of the voice, and the stroke of the gesture, co-operate in presenting the idea in the most lively manner, to the eye as well as to the ear.

There are other points of analogy between the voice and gesture, which deserve consideration. In the simple

and narrative parts of a discourse, there is little effort or variety of expression in the voice. Under the same circumstances, the gesture, if any is used, should be tame and simple; but in the more impassioned parts, both should be equally exerted. The gesture, also, in many instances, nearly imitates the manner of the inflections of the voice. When the voice rises, the gesture naturally ascends; and when the voice makes the falling inflection, or lowers its pitch, the gesture follows it by a corresponding descent; and, in the level and monotonous pronunciation of the voice, the gesture seems to observe a similar limitation, by moving rather in the horizontal direction, without much varying its elevation.

Some writers say, that "in calm discourse the words and the gestures should generally accompany each other; but in impassioned discourse, the feelings of the speaker should first be manifested in the eyes; then, by the countenance; next, by the gesture; and lastly, by the words." This is not just. In all discourse, whether calm or impassioned, the words and the gestures should accompany each other. As, in beating time in music, the beat is made on the accented part of the measure, so in speaking, the stroke of the gesture should fall on the accented syllable of the emphatic word. The emotion which calls forth the word, at the same moment, prompts the gesture. Hence, the muscles of gesticulation should move synchronously and harmoniously with those of the voice. When gesture is not marked by the precision of the stroke, in the proper places, it is very offensive. The arms, like those of a person groping in the dark, seem to wander about in quest of some uncertain object; and the action is of that faulty kind which is called *sawing the air*. Even graceful motions, unmarked by the precision of the stroke of the gesture, as sometimes seen, particularly among singers on the stage, lose much of their force, and very soon cease to afford pleasure. All the unmeaning motions of public speakers are attended with the same ill effect as a mouthing and canting tone of declamation, which lays no emphasis with just discrimination, but swells and falls with a vain affectation of feeling, and with

absolute deficiency both in taste and judgment.

The Classification of Gesture.—The arms, as well as the hands, may be employed, in gesticulation, separately or together, each using similar, or dissimilar actions. Each arm may perform similar gestures when the body of the speaker is presented towards the person addressed precisely in front; but when the body is not so presented, the gestures will not be similar; and as such posture and gestures are not graceful, they are not frequently used.

The advancement of one hand before the other is an indication of precedence, as is, also, in general, its higher elevation. The advanced hand, therefore, is said to perform the *principal gesture*. In general, the elevation of the retired arm is a whole position lower than that of the advanced arm: and, though the gesture of the retired hand occasionally resembles that of the advanced hand, yet its action is performed with less energy and authority. For these reasons, the action of the retired hand is called the *subordinate gesture*.

There is a class of gestures called *significant gestures*; the extending of the index-finger towards persons or things, points them out; the laying of the hand on the breast refers to the feelings of the speaker; the placing of the finger on the lips signifies an injunction of silence, &c.

But gestures, in general, are too vague to be comprehended under this description; they denote a sort of general relation in the expressions—their power to do this is derived from the time and manner of their application, from the place in which they are used, and from their various combinations. Some are used at the beginning of a sentence, merely to indicate a commencement in action, as well as speech; some are used for description; some for explaining, extending, or limiting; and some for enforcing the predominant idea; some for keeping the audience in suspense, till the more decisive gestures; and some for marking the termination of the sense, and the final result of the reasoning. These various gestures may be divided into five classes. 1. *Commencing gestures*. 2. *Discriminating gestures*. 3.

Auxiliary gestures. 4. *Suspending gestures*. 5. *Emphatic gestures*.

1. *Commencing Gestures* are made simply by raising the hand from rest; and that, in general, not higher than the horizontal position. They are used at the beginning, and at the divisions of a discourse.

2. *Discriminating Gestures* comprehend all those gestures which serve to indicate persons and objects, as well as those which are used for explaining, extending, limiting, or modifying the predominant idea, and those which are employed in question and answer, when made without vehemence. They are performed in the intermediate degrees of the range of the gesture, with moderate force, and at small intervals. In colloquial intercourse they are frequently confined to the motions of the head.

3 *Auxiliary, or alternate Gestures*, serve to aid, or enforce the gesture of the advanced hand. They are performed as follows; after the advanced hand has made its gesture on the emphatic word, instead of passing to another gesture, on the next emphatic word, it remains in the attitude of the last stroke till the retired hand is brought up in aid of it, either by a similar gesture, or by a more decisive one. In this way, variety and extraordinary energy are given at once, to passages which admit of such gestures. Of course, these gestures are used with great advantage in high passion; they are also frequently employed in description, where they are executed more tamely.

4. *Suspending, or preparatory Gestures*, are so called because they hold the audience in suspense, by the elevation or contraction of the arm, preparatory to the stroke which is to fall on the emphatic word.

5. *Emphatic Gestures* mark, with force, words opposed to, or compared with each other; and more particularly, the word which expresses the predominant idea. Their stroke is generally arrested on the horizontal elevation. Sometimes, however, emphatic gestures are directed to the highest point in their range; at other times, to the lowest. When they are directed to a high point, they often serve as suspending, or preparatory gestures, to the next emphatic gesture; and when made at the close of a sentence, they serve

as terminating gestures; because when the last important idea is marked, no other gesture should be added, to weaken its effect; the arm should then fall to rest.

These five classes of gestures may be used in any part of an oration. They are, as it were, the elements of gesture, which by their combinations, produce its whole power of language and expression. These elements are the component parts of every style of delivery, whether tame or vehement, argumentative or diffuse, ardent or indifferent, cold or pathetic.

The Preparation, Transition, and Accompaniment of Gesture.—In the transitions of gesture, the hand and arm should not, in general, be precipitated to the intended position by the shortest course; but in the calmer parts of the oration, they should move in a sort of waving line, or in one returning upon itself.

The transition of gesture relates to the manner of arriving at a gesture, and to the changes of gesture; and signifies either the particular changes of the position of the hand and arm, or the general change of the principal gesture from one hand to the other.

A gesture may have a very different character and effect, according to the manner in which the hand arrives at its destined point. It may ascend, descend, move towards the right, or towards the left, and may also make the stroke with various degrees of energy, and in various ways; and these motions constitute in each, an absolutely different gesture, though after the moment of the stroke, which a painter might choose to represent, the hand and arm of each should be in the same precise position. As, however, the emphatic gestures are liable to ambiguity, on account of the various transitions which might be supposed to bring them to their stroke, painters more frequently choose to represent the suspending gestures, which give an idea of action, and greater interest to their principal figures.

But the transition of gesture particularly relates to the change of the principal gesture from one hand to the other; which may be regulated, in some measure, according to the following principles. So long as there subsists a strict connection between the sentiments, uninter-

rupted by any considerable pause, or change of persons, no transition can take place in this last sense: the same hand which began, continues to perform the principal gesture. And the variety which it is always desirable to produce, must not be attempted by the change of the principal gesture: it must arise alone from the graceful and well-regulated action of the advanced hand, supported by the combined assistance or accompaniment of the other. If the passage to be pronounced be of considerable length, the right hand should perform the principal gesture throughout the whole of it. For the left, though allowed to take its place occasionally, according to certain rules, by no means arrives at an equality of honour. The right hand always continues the better hand, both from long prescription, and the ability arising from use.

In the narrative parts of an oration, where different persons or things are to be described as variously disposed, or in the recitation of descriptive poetry, when a picture, as it were, is to be represented by the speaker, consisting of many natural objects in different parts of a landscape, of which Gray's "Elegy in a Country Churchyard" will afford many examples, the right hand having first pointed out those persons or objects supposed to lie adjacent to itself, may yield to the left the arrangement and ordering of those other parts, which may be imagined to be at his own side. This interchange, judiciously regulated, produces a pleasing variety in the gesture; and if the speaker possess the imagination of a painter, his disposition and colouring will produce the most distinct and vivid picture.

Variety, which is a most important object to be kept in view by a public speaker, allows with advantage, an interchange of the principal gesture, even when the subject may be of a more abstruse and demonstrative nature. When there is any opposition or antithesis, among the ideas, or even in the structure of sentences, or where a new argument is introduced, after the discussion of a former is ended, as at a new division, or a new paragraph, there may be a change of the principal gesture. But it will be a point of judg-

ment and taste in the speaker not to carry this balancing, or alternation of gesture to an affected extreme, and not even in allowable cases, to indulge in it overmuch; nor will he prolong too far the principal action permitted to the left hand, which he will always remember is the weaker, and admitted into the foremost place rather by courtesy than of right; and which he will, therefore, restrict with discretion, in the exercise of this occasional distinction.

In the changes made from one hand to the other, the transition should be managed with ease and simplicity. As soon as the advanced hand has made the stroke of its last emphatic gesture, it should fall quietly to rest, whilst at the same time the hand which is, in its turn, to assume the principal action, commences its preparation for the ensuing gesture. It will be observed that a commencing, or discriminating gesture, should be gentle, as a modest beginning suits its first entrance into authority. An emphatic gesture immediately after one from the other hand, would be violent and outrageous; something like the gesticulations of those little wooden figures set up to frighten birds from corn, or fruit, which have the arms fixed on an axis in such a manner that they are alternately raised and depressed with equal vehemence, according as they are blown about by the wind.

When the orator finds it necessary to change the position of the feet, so as to advance that which was before retired, the general rule is that he should effect it imperceptibly, and not commence the change till after the hand has begun its change of action. Sometimes, however, in vehement passages, the orator is allowed, by the highest authority, to advance suddenly and even to stamp.

The general rule for accompaniment of gesture, in calm and moderate speaking, when both hands do not perform the same gesture, is that the retired arm should be about one interval less raised than the advanced arm, and that in the transverse position it should be distant from it about two intervals, or a right angle.

Besides the motions of the subordinate gesture, other very important accompaniments are to be attended to; as those

of the lower limbs of the body, and of the head; otherwise the performance will be rigid and absurd, like that of a puppet. Indeed, not only those more prominent and distinguished parts must accompany the voice and principal action of the speaker, but every muscle of the body, and every expression of the countenance, must join in harmony with those gestures, in order to impress upon them the character of nature and truth. There is no gesture, or change of gesture, which is not meant to enforce or to illustrate some new circumstance, which either calls into action muscles before at rest, or into a change of action those already in exertion. And this impression and influence extend not only to those muscles which are most strong and distinguished, but even to the most delicate fibres of the human frame, such as those which adjust the expression of the mouth, of the nostrils, of the brows, and of that wonderful organ the eye.

The Frequency, Moderation, and Intermision of Gesture.—As gesture is used for the illustration or enforcement of language, it should be limited, in its application, to such words and passages only as admit, or rather require, such illustration or enforcement. That is, gesture should not be used by a public speaker on every word where it is possible to apply it without manifest impropriety; but it should rather be reserved for such passages as require to be rendered more prominent than the others, and to be more highly coloured. A judicious speaker will therefore reserve his gesture, at least the force and ornament of it, for those parts of his discourse for which he also reserves the brilliancy of language and thought. Sometimes, the absolute intermission of gesture is advantageous, as in the commencement or opening of arguments. When an argument is nearly concluded, moderate gesture will give it more force, and relieve the monotony of a mere dry demonstration, should the spirit of the composition admit such addition.

In all discourses, the frequency of gesture will be determined, in general, by the number, the novelty, and the discrimination of ideas. In every well-constructed sentence, some new idea is advanced, which may be marked by a suitable

gesture; and possibly the various limitations and modifications of it will also admit of a similar distinction. Thus each separate clause, or member of a sentence, may admit a distinct gesture on the principal word; and as each epithet is a distinct quality, added to the principal name, and as each adverb has the same effect on the principal action expressed by the verb, a new gesture may be made on each. But for this purpose, unless the word is emphatic, a turn of the hand, a small motion in the transverse or vertical direction, or a slight inclination of the head, is sufficient.

In a sentence where every word is emphatic, each may be marked with a gesture. Sentences of this kind generally condense, in a small compass, valuable information, and should therefore be strongly enforced and marked with precision. They should, however, be delivered distinctly and *deliberately*, or the gestures will confuse the sentiment, and even cast a degree of ridicule upon it.

Applied to a vehement passage, the arm should be raised higher than when it is applied to one of the contrary character. A judicious speaker will often omit his gesture altogether, and use it only when absolutely necessary to illustrate or to enforce his sentiments. Gesture may be said to hold the place of high seasoning; it must, therefore, be managed with discretion, lest it should defeat its own purposes, and create disgust. If a speaker proves truly eloquent, he is sure of the most liberal and solid approbation. But he should not hazard too much; he should be guarded in the commencement of his discourse, and should restrain his gesture in the calm and reasoning passages, reserving its force and brilliancy for the appropriate expression of his most earnest feelings and boldest thoughts. His transitions from the narrative parts to those which are most highly wrought, and which require his utmost exertions, should be gradual and just, and free from extravagance. We cannot impress too strongly upon those of our pupils who are practising elocution, the necessity of a careful attention to the remarks we have made on the important subject of a gesture. In a concluding article, we shall give some further advice.

LEARNING TO SPELL.

BAD spelling is discreditable. Every young man should be master of his native tongue.

He that will not learn to spell the language that is on his tongue, and before his eyes every hour, shows no great aptitude for the duties of an intelligent, observing man. Bad spelling is, therefore, an unavoidable indication. It indicates a blundering man—a man that cannot see with his eyes open. Accordingly, we have known the application of more than one young man, made with great display of penmanship, and parade of references, rejected for his bad spelling.

A bright school-boy, utterly incapable of appreciating your stories of science, art, and literature, can see your bad spelling at a glance, and crow over it. You will find it hard to inspire that boy with any greater respect for your attainments. Bad spelling is, therefore, a very mortifying and inconvenient defect. We have known men, thrown into prominent positions, so ashamed of their deficiency in this respect, that they had never ventured to send a letter till it had been revised by a friend. This was, to say no more, sufficiently inconvenient.

I say again, learn to spell, young man. Keep your eyes open when you read, and if any word is spelled different from your mode, ascertain which is right. Keep your dictionary by you, and in writing, whenever you have the least misgiving about the spelling of a word, look it out at once; and remember it. Do not let your laziness get the better of you.

INCREASE OF THE ANGLO-SAXON RACE.—One of the most important facts connected with the present age is the unparalleled increase of the Anglo-Saxon race in numbers, wealth, and influence, within the last two hundred years. In the early part of the seventeenth century, England, Wales, and Scotland numbered only about 6,000,000 and as a nation was classed amongst the second-rate powers of Europe. Now, at the present time, the English language is spoken by upwards of 60,000,000, scattered over every island and continent of the earth.

LESSONS IN FRENCH.

THE ADJECTIVE.

THE adjective is a word which is joined to a noun to qualify or modify it.

Thus the use of the adjective in speech, always supposes the presence of a substantive.

When I say, A wise man, *un homme sage*, *homme* is a substantive, which, without the word *sage*, applies to any individual of the male race of man; but as soon as this word *sage* is added to it, the idea represented by the two words, *homme sage*, does not designate any man, but one among them who has the quality of being *wise*; thus *wise* qualifies and modifies the substantive *man*, and accordingly is an adjective.

We have already stated that nouns are sometimes used as adjectives, and adjectives as nouns. But it is proper to notice here, that this last transformation never takes place when we speak of living beings; for being always, in this case, of the same gender as the noun they represent, they always suppose the apposition of this noun to them; so that when employed, the sentence has the character of an *ellipsis*; thus, when we say, for the Almighty, *L'Eternel*, *Le Tout-puissant*, the noun *God* is understood, and, *God* being masculine, the adjective can only be used in that gender. The wise (man), *Le sage*; The select (men), *Les élus*; Learned men, *Les savants*; A prude (woman), *Une prude*.

In these examples, the word *man*, *homme*, is understood in the first, *hommes* in the second and third, *femme* in the last.

Sometimes, it is true, these adjectives in similar cases are accompanied by another adjective, which seems to modify them as it would a noun; but if we analyze those expressions we shall discover that these qualificative adjectives act only as an adverb should, and, in fact, take the place of one: A true wise (man), *Un vrai sage*, means a man *truly wise*, *un homme vraiment sage*. A false devotee, *Une fausse dévote*, means, a woman falsely religious, *une femme faussement dévote*.

Even when the adjective does not refer to a living being, if it designates an attribute, belonging to a class of things

which may be expressed by a noun, it should be always considered as an adjective; thus, The acids of the stomach, *Les acides de l'estomac*; The thick part of the blade, *Le fort de l'épée*; The purgatives, *Les purgatifs*; A perpendicular, *Une perpendiculaire*, signify, *Les (sucs) acides de l'estomac*; *Le (endroit) fort de l'épée*; *Les (remèdes) purgatifs*; *Une (ligne) perpendiculaire*.

The adjective is, then, only taken as a noun when it expresses an idea which may, *positively* and *actually*, be applied to things of different species; as in the following, What is true persuades, *Le vrai persuade*; What is honest must be preferred to what is agreeable and useful, *L'honnête doit être préféré à l'agréable et à l'utile*.

The first proposition is true when speaking of a *narrative*, a *system*, an *argument*, a *gesture*, a *sadness*, a *desire*, &c., but it does not designate any of these ideas in particular, and represents what is spoken of only as a thing, the nature of which is *truth*.

The same construction may be applied in the second sentence when the subject spoken of is what is *honest*, *agreeable*, and *useful*.

Variation of the Adjectives.—The nature of adjectives being, as we have already stated, to express the qualities of nouns, by identifying themselves with them, they must both have the same characteristics, and always be of the same number and gender.

Besides, the adjective may qualify the noun to which it is joined in a manner more or less extended; this is what is called, by grammarians, degrees of signification in the adjectives.

We have, then, three distinct parts to consider in adjectives; the *gender*, the *number*, the *degrees of signification*.

OF THE GENDER IN THE ADJECTIVES.

Formation of the Feminine in Adjectives ending with e mute.—All adjectives have for their termination in the masculine either an *e* mute, another vowel, or a consonant.

All adjectives in the feminine are ended with an *e* mute.

Thus, those which end with an *e* mute in the masculine, do not change their termination in the feminine; such are the following: Ridiculous, *Ridicule*; A ridi-

culous man, Un homme *ridicule*; A ridiculous woman, Une femme *ridicule*. Exceptions: Traitor, traître, traitresse; Devilish, diable, diableresse; Master, maître, maîtresse.

Of Adjectives ending with a Vowel which is not a mute e.—Adjectives, which in the masculine end with any other vowel than an *e* mute, make their feminine by the addition of an *e* mute to the masculine termination. Enchanté, *enchantée*, Enchanted; poli, *polie*, polished; bleu, *bleue*, blue.

There is but one exception to this rule, which is, Favourite, *favourite*.

Of Adjectives ending in an, ien, on.—Adjectives ending in the masculine in *an, ien, on*, besides the addition of an *e* mute, double their last consonant in the feminine; as, Christian, Chrétien, *Chrétienne*.

The Academy, in stating this rule, marks as exceptions: English, Anglican, *Anglicane*; Benign, *bénin*, makes *bénigne*; Cunning, *malin*, makes *maligne*.

Of Adjectives ending with a Consonant which is neither m or n.—Adjectives ending in the masculine with any other consonant than *m* or *n*, make their feminine by the addition of an *e* mute to their last consonant; as, Great, grand, *grande*.

But this rule has an immense number of exceptions. We will explain them one after another.

Of Adjectives ending in c and d.—Adjectives ending with the letter *c* make their feminine in two ways; some add *he* to the masculine; as, Frank, franc, *franche*.

Others make their feminine by changing *c* into *que*; as, Public, public, *publique*.

The adjective Greek, *grec*, makes its feminine by keeping the *c* and adding *que*; *grecque*; Raw, *crud*, makes *crue*.

Of Adjectives ending in f.—Adjectives ending with *f* in the masculine, make their feminine by changing *f* into *ve*; as, Brief, *bref*, *brève*.

Of Adjectives ending in g.—Adjectives ending in *g*, make their plural by adding *ue* to the masculine; as, Long, long, *longue*.

Of Adjectives ending in el, eil, ol, ul, as, os, ot, and et.—Adjectives ending in *el, eil, ol, ul, os, ot, et*, make their feminine by

doubling the last consonant and adding an *e* mute.

Of Adjectives ending in eur, teur, erieur.—Adjectives ending in *eur* have several modes of termination for the feminine. Those in *eur* derived from a present participle by changing *ant* into *eur*, make their feminine by changing *eur* into *euse*; as, Dancer, danseur, *danseuse*.

Those ending in *teur*, unless they are derived from a present participle, as in the preceding examples, change *eur* into *trice*; as, Accuser, accusateur, *accusatrice*.

Exception.—The following adjectives, although derived from present participles, make their plural in *trice*; as, Debtor, débiteur, *débitrice*; Executor, exécuteur, *exécutrice*.

Those ending in *érieur* make their feminine by adding an *e* mute to this termination; as, Exterior, extérieur, *extérieure*.

There are a great number of nouns with this termination that must not be mistaken for adjectives, and make their feminine terminations in different manners; they are easily distinguished from adjectives by placing the word *man*, or *woman*, before them, and seeing if, thus accompanied, they are used in the language. A good dictionary is the best rule for such cases.

There are also some adjectives terminating in *eur*, which have no feminine termination, and are used for either gender; such as, Lover of arts, amateur, *amateur*; Author, auteur, *auteur*; Conqueror, vainqueur, &c., *vainqueur*, &c.

Of Adjectives ending in x.—Adjectives ending in *x*, change this letter into *se*, in the feminine; as, Courageous, courageux, *courageuse*.

Exceptions: Reddish, roux, *rousse*; False, faux, *fausse*; Sweet, doux, *douce*; Prefixed, préfix, *préfixe*.

Of Adjectives having two terminations in the Masculine, according as they are placed before a Vowel or a Consonant.—Five adjectives are entirely defective in their feminine termination, and, besides, change their masculine according to the letter which begins the next word, whether it is a consonant or a vowel; as,

Foolish,	{	before a consonant or <i>h</i> aspirated,	fou,	{	folle,
		„ vowel or <i>h</i> mute,	fol,		
Old,	{	„ consonant or <i>h</i> aspirated,	vieux,	{	vieille.
		„ vowel or <i>h</i> mute,	vieil,		

Beautiful,	{	before a consonant or <i>h</i> aspirated,	beau,	{	belle.
New,	{	„ vowel or <i>h</i> mute,	bel,	{	
	{	consonant or <i>h</i> aspirated,	nouveau,	{	nouvelle.
	{	„ vowel or <i>h</i> mute,	nouvel,	{	
Soft,	{	consonant or <i>h</i> aspirated,	mou,	{	molle.
	{	„ vowel or <i>h</i> mute,	mol,	{	

Of Adjectives which are used only in the Masculine or in the Feminine.—Some adjectives have no feminine; as, Active, dispos; Foppish, fat; Pale, paillet, &c.

Some have no masculine: as, Mellow, blette, &c.

NOUNS AND ADJECTIVES OF NUMBER.

Numbers are divided into five classes; as, 1st. Cardinal; 2nd. Ordinal; 3rd. Collective; 4th. Distributive; 5th. Proportional.

A TABLE OF CARDINAL, ORDINAL, AND COLLECTIVE NUMBERS.

Cardinal Numbers.		Ordinal Numbers.		Collective Nouns of Number.	
1	un, <i>m.</i> une, <i>f.</i>	premier	1st	unité	unit
2	deux	deux-ième, second	2nd	couple, paire	couple
3	trois	trois-ième	3rd	trio	trio
4	quatre	quatr-ième	4th	deux-couples	two couples
5	cinq	cinq-uième	5th		
6	six	six-ième	6th	demi-douzaine	half-a-dozen
7	sept	sept-ième	7th		
8	huit	huit-ième	8th	huitaine	eight
9	neuf	neu-vième	9th	neuvaine	nine days of prayer
10	dix	dix-ième	10th	dixaine	half-a-score
11	onze	onz-ième	11th		
12	douze	douz-ième	12th	douzaine	dozen
13	treize	treiz-ième	13th		
14	quatorze	quatorz-ième	14th		
15	quinze	quinz-ième	15th	quinzaine	fortnight, fifteen
16	seize	seiz-ième	16th		
17	dix-sept	dix-sept-ième	17th		
18	dix-huit	dix-huit-ième	18th		
19	dix-neuf	dix-neu-vième	19th		
20	vingt	vingt-ième	20th	vingtaine	a score
21	vingt-et-un	vingt-et-unième	21st		
22	vingt-deux	vingt-deuxième	22nd		
30	trente	trentième	30th	trentaine	a score and a half
31	trente-et-un, &c.	trent-et-unième	31st		
40	quarante	quarantième	40th	quarantaine	two scores
41	quarante-et-un, &c.	quarante-et-unième	41st		
50	cinquante	cinquantième	50th	cinquantaine	two scores and a half
51	cinquante-et-un, &c.	cinquante-et-unième	51st		
52	cinquante-deux	cinquante-deuxième	52nd		
60	soixante	soixantième	60th	soixantaine	three scores
61	soixante-et-un, &c.	soixante-et-unième	61st		
70	soixante-dix	soixante-dixième	70th		
71	soixante-et-onze	soixante-et-onzième	71st		
72	soixante-douze, &c.	soixante-douzième	72nd		
80	quatre-vingts	quatre-vingtième	80th	quatre-vingtaine	four scores
81	quatre-vingt-un	quatre-vingt-unième	81st		
90	quatre-vingt-dix	quatre-vingt-dixième	90th		
91	quatre-vingt-onze, &c.	quatre-vingt-onzième	91st		
100	cent	centième	100th	centaine	five scores
101	cent-un, &c.	cent-unième, &c.	101st		
200	deux-cents	deux-centième, &c.	200th	deux centaines	ten scores
1,000	mille	millième	1,000th	un millier	one thousand
2,000	deux-mille, &c.	deux-millième	2,000th	deux-milliers	two thousand
10,000	dix-mille	dix-millième	10,000th	une myriade	a myriad
1,000,000	un million	millionième	millionth	un million	a million
1,000,000,000	un billion	billionième	billionth	un billion	a billion

The formation of the ordinal adjective from the cardinal is so simple, that it requires no further explanation.

Of numerical Adjectives used in speaking of the Days of the Month.—When, in French, we speak of the days of the month,

instead of using the ordinal number, as is done in English, we employ the cardinal; as, the eighth of April, *Le huit Avril*, or *d'Avril*; The twenty-sixth of the next month, *Le vingt-six du mois prochain*.

But, however, when we speak of the

first day of the month, we keep the ordinal number as in the English; as, The first of January, *Le premier Janvier*—*Le premier de Janvier*.

This exception does not extend any further; to say, The second day of the month, *Le second du mois*, is not correct.

Of the numerical Adjective onze (eleven).—Although the number *onze* (eleven) begins with a vowel, the article singular, *le*, *la*, does not make an elision before it, and *les* is pronounced as if the word *onze* began with an *h* aspirated: as, The eleventh of March, *Le onze de Mars*; The eleven apples were good, *Les (h) onze pommes étaient bonnes*.

Of the formation of Compound Numbers.—In the formation of some of the compound numbers, the word *one* is placed between the first and the last part; as in, Twenty-one, *vingt-et-un*; Thirty-one, *trente-et-un*; Forty-one, *quarante-et-un*; Fifty-one, *cinquante-et-un*; Sixty-one, *soixante-et-un*; Seventy-one, *soixante-et-onze*.

This rule does not extend to any other number, and it would be wrong to say, *vingt-et-deux*, *trente-et-quatre*, &c. This mode of counting in English, *one and twenty*, *six and thirty*, &c., is not used in French.

Of the Numerical Adjective one, un, with the words hundred and thousand.—*One*, or *a*, placed before the words *hundred* and *thousand*, in English, are suppressed in French; thus, *one hundred*, *one thousand*, are expressed by *cent*, *mille*.

Of Numerical Adjectives used in Poetry, Music, Games, &c.—There are, besides the numerical adjectives already mentioned above, many others used in poetry, music, games, &c.; as, *Distich*, *distique*; *Tiercet*, *tercet*; *Quatrain*, &c., *quatrain*; *Solo*, *solo*; *Duet*, *duo*; *Music in three parts*, *trio*; *Quartet*, &c., *quatuor*, &c.; *Two number ones*, (playing with dice), *beset*; *Two number sixes*, (playing with dice), *sonnet*, &c.

Un millier is very often employed for *one thousand weight*. *Quintal* is only used in the sense of *one hundred weight*.

Of Distributive and Proportional Numbers.—The *Distributive Numbers* are those expressing the different parts of a whole; as, The half, *la moitié*; The third, *le tiers*; The fourth, *le quart*; The fifth, *le cinquième*, &c.

The *Proportional Numbers* denote the progressive increase of things; as, The double, *le double*; The treble, *le triple*; A hundred fold, *le centuple*, &c.

OF NUMBER IN ADJECTIVES.

Adjectives agreeing in number, as well as in gender, with the nouns which they qualify, it becomes necessary now to examine what alterations they suffer in their termination when joined to a noun in the plural.

General Rule.—Adjectives, whatever may be their termination, form their plural by the addition of an *s* to the feminine and masculine; as, Good, *Bon*, *bons*, (masculine); *Bonne*, *bonnes*, (feminine.)

This rule has no exceptions for the feminine termination; as to the other, there are two cases in which this rule is not observed.

1st. Adjectives ending in *s* or *x* in the singular, do not change in the plural: as, Big, *gros*, *gros*; Hideous, *hideux*, *hideux*.

2nd. Adjectives ending in *au* and *al* make their plural by changing this termination into *aux*; as, Beautiful, *beau*, *beaux*; General, *général*, *généraux*.

All cardinal numbers indicate the plural, except *one*, *un*; for it would be absurd if a word, which in all cases denotes a plurality, should be followed by a singular noun: thus, two, *deux*; ten, *dix*; twenty, *vingt*, &c., are always in the plural; as, Two men, *deux hommes*; Ten years, *dix ans*; Twenty days, *vingt jours*, &c.

Of the Adjectives vingt and cent.—The adjective *quatre-vingts* takes the plural termination in the word *twenty*, provided it is not followed by another number; as, Eighty men, *quatre-vingts hommes*; Eighty-two men, *quatre-vingt-deux hommes*.

The adjective *hundred* takes the plural in the same cases; as, Two hundred days, *deux cents jours*; Two hundred and one days, *deux cent-un jours*, &c. But these two adjectives do not take the plural when they are used instead of the ordinal adjectives, *centième* and *millième*; as, Charlemagne died in the year 800, *Charlemagne mourut en l'an huit cent*; This great calamity happened in the year 580, *Ce grand malheur arriva en l'an cinq cent quatre-vingt*.

Of the Numerical Adjectives mille and

mil, one thousand.—The adjective *thousand*, *mille*, never takes the plural; as, Ten thousand men, dix mille hommes; One thousand men, mille hommes.

The word *thousand* employed in dates is written *mil*, and means only ten hundred; as, In 1830, en mil huit cent trente.

Although this example is correct, it is more elegant to say for, In eighteen hundred and thirty, en dix-huit cent trente.

The word *mille*, used as a noun, and meaning a *mile*, follows the rule of nouns and takes the plural; as, A hundred miles, cent milles.

Remark.—It is to be remarked that in French the conjunction *and*, *et*, is never used in the formation of adjectives of number. We do not say, for two hundred and fifty, *deux cent et cinquante*, but *deux cent cinquante*; the reason for this rule is, that a numerical adjective, whatever may be the number of words of which it is composed, is but *one* qualificative, which does not admit therefore that *and*, *et*, which separates the adjective into parts, should convey the idea of several.

The fact of *et* being used in the adjectives *vingt-et-un*, *trente-et-un*, &c., is not a derogation to this rule, because in these cases *et* is only used for the sake of euphony, and is dropped as soon as it ceases being necessary to please the ear; thus we say, *Quatre-vingt-un*, *cent-un*, &c.

Remarks on the Formation of the Plural in several Adjectives.—The adjective, *pénitentiel*, makes its plural, *pénitentiaux*; Penitential psalms, Les psaumes *pénitentiaux*. Universal, *universel*, makes its plural *universels*, when employed as an adjective, but taken as a noun used in philosophical discussions, it is written *universaux*. La these des universaux a fait dans les siècles passés un grand sujet de dispute parmi les écoles; the thesis on universals has been in past ages a great cause of dispute among the scholars.

Adjectives ending in *ant*, *ent*, follow the general rule, keeping the *t* and adding an *s* in their plural: Caressing, caressant, caressants; Contented, content, contents.

But when using the qualificatives in *ant*, we must ascertain if they are really qualificatives or present participles, for in this last case they neither take the plural nor feminine: Ces deux femmes, *craignant*

de le chagriner, l'ont perdu dès sa jeunesse; these two women, fearing to cause him pain, have spoilt him from his youth.

The adjective, *all*, *tout*, is an exception to the preceding rule, because it drops the *t* in the plural: All men are equal, Tous les hommes sont égaux.

The adjectives ending in the singular masculine in *al* are divided, with regard to the formation of their plural, into three categories.

Most of them change *al* into *aux*.

Some only add an *s* to the singular.

Some, by being never joined to a masculine noun, have no plural in this gender, and then follow the general rule of feminine adjectives.

1st. Adjectives in *al*, making their plural *aux*: Annual, annal, annaux; and many others. Adjectives in *al*, making their plural by adding an *s*: Fatal, fatal, fatals.

Adjectives in *al*, having no plural in the masculine: Beneficial, *bénéficial*, *bénéficiales*; (Plural feminine.) Diagonal, diagonal, diagonales; Borial, *boréal*, *boréales*; Brumal, brumal, brumales; Crural, crural, crurales; and several others.

Degrees of Signification of the Adjectives.

—There are three degrees of signification in the adjectives; the positive, the comparative, and the superlative.

The Positive is the adjective itself, expressing the quality of the noun without any increase or diminution; as, Merit is modest, Le mérite est *modeste*; Gold is precious, L'or est *précieux*.

The comparative is so called, because it expresses a comparison between two or several objects. If we compare persons or things together, some are either equal, superior, or inferior, to the others; thus there are three sorts of comparatives—that of equality, that of superiority, and that of inferiority.

Comparison of Equality.—The comparative of equality is formed by adding *aussi*, *as*, in affirmative sentences, and *aussi* or *si* in negative ones, before the adjective, and *que*, *as*, after it; as, Gold is not so precious as diamond, L'or n'est pas *aussi*, or *si*, précieux *que* le diamant; I am as good as you, Je suis *aussi* bon *que* vous.

Comparison of Superiority and Inferiority—The comparative of superiority is formed by placing *plus*, *more*, before the

adjective, and *que, than*, after it; as, Gold is more precious than silver, *L'or est plus précieux que l'argent*.

In English the comparative of superiority is formed either by placing *more* before the adjective, or by adding *er* to the termination of the adjective: but these two modes of expression must be rendered in the same manner in French; as, Peter is richer than Paul, *Pierre est plus riche que Paul*.

The comparative of inferiority is formed by prefixing *moins, less*, to the adjective, and placing *que* after it; as, Silver is less precious than gold, *L'argent est moins précieux que l'or*.

When several adjectives qualify the same noun, each one must be preceded by one of the adverbs, *aussi, plus, moins*, according to the nature of the comparison, and the last adjective followed by *que*; as, This woman is as beautiful, as good, and as young as yourself, *Cette femme est aussi belle, aussi, bonne, et aussi jeune que vous*; This man is less beautiful, less good, and less young than yourself, *Cet homme est moins beau, moins bon, et moins jeune que vous*; This young lady is more handsome, more amiable, and younger than yourself, *Cette demoiselle est plus belle, plus, aimable, et plus jeune que vous*.

"More" or "less" used as adverbs of Quantity.—When *more* or *less, plus* or *moins*, are used as adverbs of quantity, and not of comparison, the conjunction *than* is expressed by *de*; as in, This book cost me more than two dollars, *Ce livre me coûte plus de deux dollars*; You cannot buy this horse for less than two hundred dollars, *Vous ne pouvez pas acheter ce cheval pour moins de deux cent dollars*. Foreigners should pay attention to this rule.

Of the Comparative Adjectives "Better," "Worse," and "Less."—There are three adjectives which are comparative by themselves: Better, *meilleur*, instead of *plus bon*; Worse, *pire*, instead of *plus mauvais*; Less, *moindre*, instead of *plus petit*.

Beginners in the study of the French language being apt to confound these comparative adjectives with the comparative adverbs, *mieux, pis, moins*, because they are rendered in English by the same words, *better, worse, less*, it is necessary, by a comparison between the two sorts of words, to show the difference of their form-

ation: Adjective, *Meilleur, better*, is the comparative of *good, bon*, and is used instead of *plus bon*, which is never used in French; Adverb, *Mieux, better*, is the comparative of *well, bien*, (adverb,) and is used instead of *plus bien*, which is never used in French; Adjective, *Pire, worse*, is the comparative of *mauvais, bad*, and is used instead of *plus mauvais*. (Both may be used in French); Adverb, *Pis, worse*, is the comparative of *mal, badly*, and is used instead of *plus mal*. (Both may be used in French); Adjective, *Moindre, less*, is the comparative of *petit, less* or *smaller*, and is used instead of *plus petit*. (Both may be used in French); Adverb, *Moins, less*, is the comparative of *peu, little*, and is used instead of *plus peu*, which is never used.

Examples.—This fruit is good, but that is better, *Ce fruit est bon, mais celui-ci est meilleur*; I love you well, but I love him better, *Je vous aime bien, mais je l'aime mieux*; His health is bad, but it has been worse, *Sa santé est mauvaise, mais elle a été pire*; He used to speak badly, but he speaks worse than ever, *Il parlait mal, mais il parle pis que jamais*; My income is small, but yours is less, *Mon revenu est petit, mais le votre est moindre*; I drink little, but you drink still less, *Je bois peu, mais vous buvez encore moins*.

THE FIRST FORGED BANK OF ENGLAND NOTE.—The day on which a forged note was presented at the Bank of England, forms a memorable era in its history. For sixty-four years the establishment had circulated its paper with freedom; and during this period, no attempt had been made to imitate it. To Richard Vaughan, a Stafford linen-draper, belongs the melancholy celebrity of having led the van in this new phase of crime, in the year 1758. The records of his life do not show want, beggary, or starvation urging him, but a simple desire to seem greater than he was. By one of the artists employed, and there were several engaged on different parts of the notes, the discovery was made. The criminal had filled up to the number of twenty, and deposited them in the hands of a young lady to whom he was attached, as a proof of his wealth.

CHEMISTRY.—HEAT.

Transmission of Heat through Bodies.—

The rays of heat from the sun, like the rays of light from the same luminary, pass through transparent substances with little change or loss. Radiant heat, however, from terrestrial sources, whether luminous or not, is in a great measure arrested by many transparent substances. If the sun's rays be concentrated by a metallic mirror, the heat accompanying them is so intense at the focus as to fuse copper and silver with ease. A pane of colourless window-glass interposed between the mirror and the focus, will not stop any considerable part of the heat. If the same mirror is presented to any other source of heat, however (as the red-hot ball, Fig. 42), the glass plate will stop nearly all the heat, although the light is undiminished. We thus distinguish two sorts of calorific rays, which are sometimes called solar and culinary heat, and we discover that substances transparent to light are not, so to speak, transparent to heat in a like degree. This property is distinguished from transparency by the term *Diathermancy*.* Bodies allowing the passage of the heat are said to be *diathermous*, while those allowing the passage of light are said to be *diaphanous*.† Bodies which completely arrest the passage of radiant heat are said to be *adiathermous*.

Bodies which are highly transparent or diaphanous, are often completely adiathermous, so that the transparency of a body is not connected with its diathermancy.

Thus glass of various sorts arrests from 47 per cent. to 67 per cent. of the rays of heat, while common alum in perfectly clear masses, allows the passage of only 9 rays in 100. On the other hand, rock-salt stops only 8 rays in 100, 92 passing freely through. These facts are easily shown, when no other means are at hand, by placing a tablet of rock-salt and one of glass in a situation to be exposed to the heat of a fire. The glass will soon grow so hot as to burn the fingers, from the quantity of heat arrested by it, while the salt will hardly be affected. A large air-thermometer, or a delicate differential one, with one ball blackened, will also answer to make many of these changes of temperature evident.

Melloni's Apparatus.—Nearly all the knowledge we possess on this interesting branch of science, we owe to the labours of a distinguished Italian philosopher, M. Melloni, who has invented a most beautiful apparatus, by which all these observations and discoveries have been made. Its general arrangement is represented in Fig. 69. The degree of heat is measured in this instrument, not by a thermometer (which would be altogether too rude an indicator of such minute changes

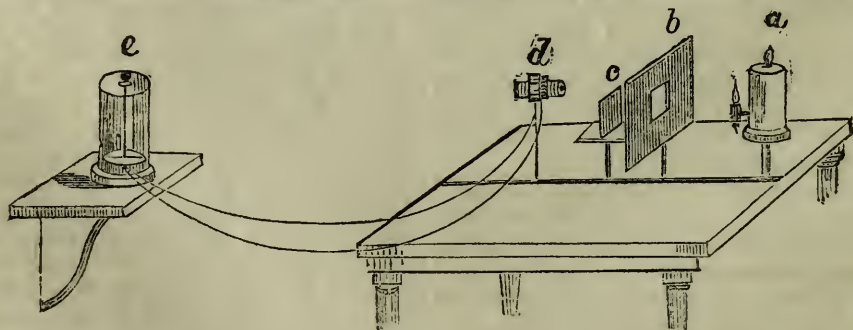


Fig. 69.

of temperature as are here shown), but by

* From the Greek *dia*, through, and *thermos*, heat, in allusion to the passage of heat through substances.

† From the Greek *dia*, through, and *phaino*, to shine.

what is called a *thermo-multiplier*, or multiplier of heat. This is an arrangement of little bars of the two metals, antimony and bismuth, about fifty of which are soldered together by their alternate ends, the whole being with its

case not more than two and a-half inches long, by one-half to one-third of an inch in diameter. The least difference of heat between the opposite ends of this little battery will produce an electrical current capable of influencing a magnetic needle, in an instrument called a *galvanometer*. The needle of the galvanometer will move in exact accordance to the intensity of the heat. This is so delicate an instrument, that the radiant heat of the hand held near the battery will cause the needle to move some 10° over its graduated circle. In the figure, *a* is the source of heat (an oil-lamp in this case), *b* a screen having a hole to admit the passage of a bundle of rays; *c* is the substance on which the heat is to fall; *d* the thermomultiplier, or battery, which is to receive the rays after they have passed through the substance *c*. Two wires connect the opposite members of this battery with the galvanometer *e*, which, for steadiness, is placed on a bracket attached to the wall. Thus arranged, and with various delicate aids which we cannot now explain, a vast number of most instructive experiments have been made on radiant heat from different sources, and its effect ascertained on various substances. Four different sources of heat were employed: (1) the naked flame of an oil-lamp; (2) a coil of platinum wire heated to redness by an alcohol-lamp; (3) a surface of blackened copper heated to 734° , and (4), the same heated to 212° by boiling water. The first two of these are luminous sources of heat, the last two not so.

The following table will show a few of the principal results:

Names of interposed substances, common thickness 0.102.	Transmission of 100 rays of heat from			
	Oil-lamp.	Red-hot platinum.	Copper at 734°	Copper at 212°
Rock-salt, transparent and colourless	92	92	92	92
Iceland Spar	36	28	6	0
Plate-glass	39	24	6	0
Rock-crystal	38	28	6	0
Rock-crystal, brown	37	28	6	0
Alum, transparent	9	2	0	0
Sugar-candy	8	0	0	0
Ice, pure and transparent..	6	0	0	0

Thus it appears that rock-salt is the only substance which permits an equal amount of heat from all sources to pass. In other cases the number of rays passing seem proportioned to the intensity of the source. M. Melloni has called rock-salt the glass of heat, as it permits heat to pass with the same ease that glass does light. It is supposed that the difference found by experiment in the diathermancy of bodies, is owing to a peculiar relation which the various rays of heat sustain to these bodies, exactly analogous to that difference in the rays of light which we call colour. Thus all other bodies, except salt, act on heat as coloured glasses act on light, entirely absorbing some of the colours, and allowing others to pass. Thus rock-salt may be said to be colourless as respects heat, while alum and ice are in the same sense almost black. Opaque bodies, like wood and metals, entirely prevent the transmission of heat; but dark-coloured crystal is seen, by the table, to differ only one from white crystal, and even perfectly black glass does not entirely stop all heat.

By cutting rock-salt into prisms and lenses, the heat from radiant bodies may be reflected, refracted, and concentrated like light, and doubly refracting minerals, like Iceland-spar, will polarize it. All these interesting results, however, we must pass without further notice.

SPECIFIC HEAT.—CAPACITY OF BODIES. FOR HEAT.

Specific heat is that amount of heat required to raise any body through a given number of degrees of temperature, as, e. g., 10° . It is a remarkable fact, and one of great importance, that the same quantity of heat cannot raise different bodies through an equal number of degrees of temperature. If equal measures (say a pint) of mercury and water be exposed to the same source of heat, we shall find that the mercury will attain its highest temperature about twice as soon as the water; and on removal from the fire, it will cool in half the time. If a pint measure of water at 150° be mixed quickly with an equal measure of the same fluid at 50° , the two measures of fluid will have the temperature of 100° , or the arithmetical mean of the two temperatures before mixture. If, however, we take one measure of water

at 150° , and an equal measure of mercury at 50° , and rapidly mix them, we shall find that they will have the temperature of 118° . The mercury has gained 68° , and the water lost only 32° , or about half as much. Hence we infer that the same quantity of heat can raise the temperature of mercury through twice as many degrees as that of water. We thus prove, by actual trial, that each body (solid, fluid, or gas) has its own relation to the amount of heat required to raise it a given number of degrees of heat, and this amount being peculiar to each body, is called its *specific heat*. As water is adopted as the standard of comparison for specific heats, the specific heat of mercury will be to water as 32 to 68, or nearly 0.47. It is more convenient to compare bodies by weight than by measure; and hence if we divide the specific heat by measure (0.47) by the specific gravity of mercury (13.5), we obtain the number, 0.035, its specific heat, by a comparison of weights. The process just described for determining specific heat, is called the *method of mixtures*.

THE PHILOSOPHER'S WORLD.

ONE of the ancient philosophers—I have forgotten his name—had so long accustomed himself to ponder over the crimes and miseries of this world, that he became altogether disgusted with it, and, being on one occasion more than commonly excited, exclaimed:—"Oh! Jupiter—Jupiter! how is it possible you could make so many blunders?" He had scarcely uttered these words, when Jupiter appeared before him, seated on a cloud, and brandishing a thunderbolt. The philosopher was not a little startled at this sudden apparition of the god, and trembled so that he could scarcely answer, when Jupiter thus addressed him:

"What wantest thou of Jupiter, O mortal! that thou callest on him so vehemently? and what are the blunders I have committed?—Speak—be not afraid, for there are none so high as to be above hearing the truth."

The philosopher hereupon took courage, and began to point out the defects, which were either innate in the original conformation of the world, and especially its in-

habitants, or had been suffered to grow up for want of proper attention on his part. He dwelt on the evils of unrestrained ambition, the rapacity of unfeeling avarice, the blood-thirsty malignity of revenge, the abuses of power, the excesses of pride, and the crimes of licentious love. Finally, he besought Jupiter either to reform the world by banishing all these passions from the human heart, or make a new one, based on sound principles of philosophy.

Jupiter was in high good humour, and took the philosopher's discourse in good part. He excused himself in the best manner possible, and concluded by asking the philosopher if he thought he could make the world better than it was, or construct a new one on improved principles, provided he had unlimited power and discretion conferred on him for that purpose. The philosopher was rather shy at first, and modestly disclaimed all pretensions to world-making, but at length, being hard pressed, acknowledged that he thought, if the power were given him, he could make some material improvements in the world as it existed at that time.

"Be it so, then," exclaimed Jupiter. "There is a vast space of the universe yet unoccupied, sufficient for a dozen more worlds. Take thy choice where to place thy world, and receive from me the power to create such a one as thou pleatest. It is but to exercise thy will, and all that thou wiltest shall be accomplished. Remember, however, that thou standest responsible to me for the consequences. Dost thou accept these terms?"

The philosopher bowed his head, and having great confidence in his own wisdom, said he was ready for the undertaking. Jupiter then disappeared, exclaiming in a voice that shook the spheres—"Go, now, and create thy world!"

The philosopher, who did not so much take exception to the physical formation of the earth, the divisions of the seasons, and the operations of the elements, framed his new world pretty much after the model of the old one in these respects. His great object was to create a race of rational beings, without those malignant and mischievous passions to which he traced all the crimes and miseries that afflicted mankind. Accordingly, he formed

a species of men without passions, but with intellects more clear and refined than those of the inhabitants of the old world, and, dividing his world among them, awaited the result of the experiment.

The first thing he observed was, that they were a set of the laziest dogs he ever met with, and did nothing but lounge about, seemingly with no other purpose than to kill time; or stretch themselves out on a sofa, or under a shady tree, dozing away the live-long day. Nothing but hunger or thirst could compel them to the least exertion, and when these were satisfied, they fell asleep again. He endeavoured to stimulate them to exertion by pointing out examples in history of those illustrious men who had attained to immortality and a seat among the gods, by the unwearied exertion of their talents and virtues; but as they were without ambition, all this was beyond their comprehension. He then expatiated on the gratifications derived from the possession of wealth, the luxuries it could purchase, and the power it conferred on the possessor; but as they knew neither avarice nor pride, his exertions were all in vain. He then appealed to the younger portion of his creatures, and placed before them, in glowing colours, the delights of mutual affection, the enjoyments of virtuous love, and the joys that flowed from the relation of parent and children. All would not do, for he addressed himself to those who, being without passions, knew nothing of love.

In a few years the philosopher's world began to be very much out at the elbows. He had made it so fruitful that a very little labour supplied the wants of the people, and as there was no motive for acquisition, when these wants were gratified, they sunk into idle inanity. Even the children never played, for as they had no ambition to excel each other, there was no motive for exertion. Having no pride in their personal appearance, they ceased to have any regard to cleanliness, and the young women became so slovenly that the philosopher, who was a great admirer of the fair sex, was disgusted with his own handiwork. But this was not the worst; for though he placed before them the influence, honours, and distinctions they might arrive at by culti-

vating the arts, sciences, and literature, they only looked at him in stupid amazement. Before half an age passed away, they had become little better than ignorant barbarians, and his new world was fast relapsing into a state of nature. But still more melancholy consequences followed. Being entirely divested of that passion which constitutes the attractive principle throughout all the varieties of created beings, instead of increasing in numbers, they gradually dwindled away; for as death thinned their ranks—the philosopher not having made them immortal—by accident, disease, or old age, there was none to supply the deficiency. By the time the first generation had passed away, the philosopher stood solitary and alone in his world.

"Oh! Jupiter, Jupiter!" cried he aloud, "what will become of me? I shall be devoured by wild beasts, or perish alone in this wilderness." Overcome by his emotions, he became for a time insensible, and on coming again to himself, perceived that he was in the same spot whence he had invoked Jupiter on a former occasion. The god was seated as before, on a bright cloud, brandishing his thunderbolts, and addressed him in the same words.

"What wastest thou of Jupiter, O mortal! Has thy world disappointed thy expectation?"

"Alas!" replied the philosopher, "I find I have committed a great error in making my people without passions, and thus depriving them of all incentive to action, except their mere animal wants. But I am of opinion that you have committed a still greater error in not conferring on man the power of directing or scrutinizing those passions which it seems are indispensable not only to his happiness, but his very existence."

"O! thou of little sense," exclaimed Jupiter; "wouldst thou have had me create gods instead of men? Had this been done, they would have been perfect beings, and in that respect equal to him by whom they were created. Even gods cannot make gods, and it is only imperfect beings that produce equals."

"Still, O! Jupiter," cried the philosopher, who was somewhat obstinate in his opinions, "I cannot see why thou

didst not make all mankind equally good, for then there would have been neither misery nor crime in the world, and all had been happy."

"Thou fool!" answered Jupiter, "knowest thou not that if all were equally free from error and vice, there would be no such thing as virtue in the world, or at least no room for its exercise? But go thy ways, and pass the few remaining years of thy life in those studies that teach humility instead of arrogance and pride." Saying this he called all his terrors around him and vanished, amid bursts of thunder and flashes of lightning.

The philosopher took his way home, where, profiting by the lessons he had received, instead of making new worlds, he passed his time in cultivating his little garden and planting cabbages.

THE SEALS RECENTLY FOUND IN THE RUINS OF NINEVEH.

OTHER corroborative evidence as to the identity of the king who built the palace of Kouyunjik with Sennacherib, is scarcely less remarkable. In a chamber, or passage, in the south-west corner of this edifice, were found a large number of pieces of fine clay, bearing the impressions of seals, which, there is no doubt, had been affixed, like modern official seals of wax, to documents written on leather, papyrus, or parchment. Such documents, with seals in clay, still attached, have been discovered in Egypt, and specimens are preserved in the British Museum. The writings themselves had been consumed by the fire which destroyed the building, or had perished from decay. In the stamped clay, however, may still be seen the holes for the string, or strips of skin, by which the seal was fastened; in some instances, the ashes of the string itself remain, with the marks of the fingers and thumb. The greater part of these seals are Assyrian, but with them are others bearing Egyptian, Phœnician, and doubtful symbols and characters. Sometimes the same seal is impressed more than once on the same piece of clay. But the most remarkable and important of the Egyptian seals are two impressions of a royal signet,

which, though imperfect, retain the cartouche, with the name of the king, so as to be perfectly legible. It is one well known to Egyptian scholars, as that of the second Sabaco, the Æthiopian, of the twenty-fifth dynasty. On the same piece of clay is impressed an Assyrian seal, with a device representing a priest ministering before the king, probably a royal signet. There can be no doubt whatever as to the identity of the cartouche. Sabaco reigned in Egypt at the end of the seventh century, before Christ, the exact time at which Sennacherib came to the throne. He is probably the So, mentioned in the second book of Kings (xvii. 4), as having received ambassadors from Hosea, the King of Israel; who, by entering into a league with the Egyptians, called down the vengeance of Shalmaneser, whose tributary he was, which led to the first great captivity of the people of Samaria. Shalmaneser we know to have been an immediate predecessor of Sennacherib; and Tirakhah, the Egyptian king, who was defeated by the Assyrians near Lachish, was the immediate successor of Sabaco II. It would seem that a peace having been concluded between the Egyptians and one of the Assyrian monarchs, probably Sennacherib, the royal signets of the two kings, thus found together, were attached to the treaty, which was deposited amongst the archives of the kingdom. Whilst the document itself, written parchment or papyrus, has completely perished, this singular proof of the alliance, if not actual meeting, of the two monarchs, is still preserved amidst the remains of the state papers of the Assyrian empire; furnishing one of the most remarkable instances of confirmatory evidence on record, whether we regard it as verifying the correctness of the interpretation of the cuneiform character, or as an illustration of Scripture history.—*Layard's Nineveh.*

SCIENCE AND RELIGION.—Men do not become irreligious in the company of Bacon and Newton, and Hunter and Davy. We will not say that learned men are necessarily good men, but at least they stand a better chance of becoming so than those whose minds know no other aim than the gratification of the daily wants of the body.



"Now have young April and the blue-eyed May
Vanish'd awhile; and lo! the glorious June
(While Nature ripens in his burning noon)
Comes like a young inheritor: and gay,
Although his parent months have pass'd away:
But his green crown shall wither, and the
time

That usher'd in his birth be silent soon,
And in the strength of youth shall he decay."

BARRY CORNWALL.

NIGHT has passed, the sable clouds are
rolling towards the west, and the resplen-
dent rays of the glorious sun are rapidly

alighting upon the gray and barren rocks;
the gushing brooks, and moss-clad walls
around us. See how the pearly dew that
hangs from yon spider's web, glitters in
the hedge of green alder, which is re-
lieved by the cerulean hue of the ash
behind it. The tremulous leaves of the
forest trees fan us, as we recline beneath
their gnarled trunks, while around us,
fresh flowers

"are springing in wood and vale,
Their breath floats out in the southern gale;"

and between the rude blocks of many a rock the blooming flowers hang. Oh!

"Shall I sing of happy hours,
Number'd by opening and closing flowers?
Of smiles, and sighs that give no pain,
And seem as they were heard in vain—
Softly heard in leafy bowers,"

when no other ears are nigh.

'Tis sweet to wander over guarded dells,
wooded mounds, or cloud-capped hills,
and contemplate Nature's charms, from
the noble forest tree that waves its
branches o'er the mountain's ridge, to
the lichen-dotted stones in the plain
below; from the pensive flowers peeping
from each chink of the ruined wall, to
the humble moss on the fallen tree, once
a proud habitant of the forest wild.

Man often wanders among the beauties
of Creation, and heeds not the wondrous
works that surround him. He turns aside
from the boundless store of knowledge
around him, or passes it by unheeded.
Not even

"The pomp of groves, and garniture of fields;
All that the genial ray of morning gilds,
And all that echoes to the song of even,
All that the mountain's sheltering bosom
shields,
And all the dread magnificence of Heaven,"

can sometimes make him remember his
Creator, and that he is as a speck on
the globe's vast surface. The man that
lives amid the charms of Nature, learns
early to adore the Being that created him,
for

"It is His presence that diffuses charms
Unspeakable, o'er mountain, wood and stream,
To think that He, who hears the heavenly
choirs,
Hearkens complacent to the woodland song;
To think that He, who rolls yon solar sphere,
Uplifts the warbling songster to the sky;
To mark His presence in the mighty bow
That spans the clouds as in the tints minute
Of tiniest flower: to hear His awful voice
In thunder speak, and whisper in the gale;
To know and feel His care for all that lives;
'Tis this that makes the barren waste appear
A fruitful field—each grove a paradise."

"The leafy month of June," gay with
brilliant flowers, and luxuriant forest
trees, affords ample food for a reflective
mind. Let those who would study Nature
in all her beauties, wander

"Amid the gardens, fragrant with the rose,
Or 'neath some hedge, where, off'ring fit for
kings,
The modest violet, and cowslip springs.

And hear the sheep, and lowing cattle join
The forest birds in symphony divine."

June is the sixth month of the year in
our calendar, but it was the fourth in the
Alban or old Latin calendar; and Romu-
lus accorded it the same position in his,
assigning thirty days as the proper limit
of the month, thereby increasing it four
days; for in the Alban calendar it had
only twenty-six days. Numa Pompilius
reduced the number of days of this month
to twenty-nine, and made it the sixth
month of the year; and Julius Cæsar
confirmed its position and restored the
day which Numa had taken away from it.

There are divers opinions respecting
the origin of the name of this month.
Some derive its name from Junius Brutus,
who expelled the Tarquins from Rome,
on the first of this month, and settled the
government upon the people; others
assert that it is derived from the Latin
word *junius*, because it is considered as
the month for young persons. The most
probable and more generally received
opinion is, that it derives its name from
the goddess Juno, in honour of whom a
festival was celebrated at the commence-
ment of the month.

June was the *Thamur* or *Tamuz* of the
Hebrews, the tenth month of their civil,
and the fourth of their sacred year. *Tha-*
mur or *Tamuz*, signifies continuance and
perfection, alluding to the almost unin-
terrupted daylight, maturation of the
fruit, &c., which occur during its con-
tinuance.

The synonymes of the month are as
follows:—in Latin, *Junius*; French, *Juin*;
Italian, *Giugno*; Portuguese, *Junho*; and
Saxon, *Sere monath*, or dry month. In the
earliest times, our Saxon ancestors called
June, *Weyd-monat*, because, says Vers-
tegan, "their beasts did then weyd in the
meddowes, that is to say, goe to feed
there, and hereof a meddow is also in the
Tutonicke, called a *weyd*, and of *weyd* we
yet retain our word *wade*, which we un-
derstand of going through watric places,
such as meddowes are wont to be." Dr.
F. Sayers considers that "*weyd* is proba-
bly derived from *weyden* (German), to go
about as if to pasture;" he also remarks,
they call it *woodmonath*; and the *wood*
means "weed;" and that they call it also
by the following names; *Medemonath*,

Midsumor monath, and *Braeckmonath*; thought to be so called from the breaking up of the soil from *bræcan* (Saxon), to break. They also named it *Lida erra*; the word *Lida* or *litha*, signifying in Icelandic, "to move or pass over," may imply the sun's passing its greatest height; and *Lida erra*, consequently, mean the first month of the sun's descent.

The ancients represented this month as a young man, clothed in a mantle of dark grass, green colour, having his head ornamented with a coronet of flowers, while he held an eagle in his left hand, and bore a basket of summer fruits upon his right arm. At his right was the sign of Cancer, the crab, alluding to the sun entering that sign on the 22nd of the month, to make the summer solstice.

Our calendar contains many remarkable days in June, which we shall at once proceed to describe.

THE FIRST DAY is dedicated to *St. Nicomede*, who was a pupil of *St. Peter*, and was discovered to be a Christian, by his honourably burying *Felicula*, a martyr. He was beaten to death with leaden plumets during the reign of *Domitian*.

In 1593, *Christopher Marlowe*, the celebrated dramatic writer, author of "*Faustus*," "*Edward the Second*," &c., was killed in a very disreputable quarrel; in 1594, *Nicholas Poussin*, the renowned painter of the "*The Death of Germanicus*," "*The Martyrdom of St. Erasmus*," &c., was born at *Andely*, in *Normandy*; and in 1794, *Richard Earl of Howe*, gained a complete and decisive victory over the French fleet, so that this day is generally called "the glorious first of June," among naval men.

THE SECOND DAY.—In 1780, the dreadful riots, headed by *Lord George Gordon*, took place in *London*; and hence they are generally known as the *Gordon Riots*.

THE THIRD DAY.—In 1822, the *Abbé René Just Haüy*, died at *Paris*. He was celebrated for his discoveries in crystallography and natural philosophy.

THE FOURTH DAY.—In 1738, was born *King George the Third*, who reigned over the British nation nearly 60 years; and in 1810, died *William Windham*, the statesman.

THE FIFTH DAY is dedicated to *St.*

Boniface, who was a Saxon presbyter, born at *Crediton*, in *Devonshire*. His name was *Winfred* or *Winefrid*, and, after being educated in a Benedictine monastery, at *Exeter*, he was sent to *Friesland* as a missionary. In 745 he was created Archbishop of *Mentz*, and was murdered in 755 by the peasantry in *East Friesland*, while holding a confirmation.

In 1783, *Adam Smith*, the celebrated author of the "*Wealth of Nations*," was born at *Kirkcaldy*, in the county of *Fife*; and in 1826, *Carl Maria Von Weber*, the distinguished musical composer, the author of "*Der Freischütz*," "*Oberon*," "*Preciosa*," &c., was found lifeless in his bed in *London*.

THE SIXTH DAY.—In 1533, died *Ludovico Ariosto*, the most celebrated of the Italian satirists, well-known for his "*Orlando Furioso*," and a variety of poems of infinite merit; in 1606, was born *Pierre Corneille*, generally denominated the father of the French drama, the author of "*The Cid*," "*Medée*," "*Polyeucte*," &c.; and in 1832, died *James Bentham*, in the eighty-fifth year of his age, known as the author of the "*History of the Church of Ely*," the "*Introduction to the Principles of Morals and Legislation*," the "*Book of Fallacies*," &c.

THE SEVENTH DAY.—In 1520, the celebrated interview between *Henry VIII.* and *Francis I.* took place near *Andres*, in *France*, and such was the costliness and richness of the tents and pavilions, that the place where they met was called *Le Champ de drap d'or*, "the field of golden cloth." In 1779, died *William Warburton*, bishop of *Gloucester*, aged eighty-one; and in 1832, the English Reform Bill received the Royal assent.

THE EIGHTH DAY.—In 1376, died *Edward the Black Prince*, in the forty-sixth year of his age; and in 1635, was born at *Perinaldo*, in the district of *Nice*, the celebrated astronomer, *John Dominic Cassini*, the elder, who did much to improve the science of astronomy.

THE NINTH DAY was kept by the Romans as the Feast of *Vesta*, when the Roman ladies walked barefooted in a procession to the temple of the goddess.

In 1623, was born at *Clermont*, in *Auvergne*, *Blaise Pascal*, a distinguished French philosopher, and author of "*Pro-*

vincial Letters;" he died at the early age of thirty-nine years.

THE TENTH DAY.—In 1735, died, aged fifty-seven, Thomas Hearne, a learned antiquary; in 1752 the London Hospital was founded; and in 1824 New London Bridge was commenced.

THE ELEVENTH DAY is dedicated to St. Barnabas, whose proper name was Joses. He was descended from the tribe of Levi, and was born at Cyprus, but educated under Gamaliel, at Jerusalem, and was associated with St. Paul, preaching the Gospel in various countries for upwards of fourteen years. He suffered martyrdom at Salamis, in his native isle, by being stoned to death by the Jews. The festival of this saint used to be observed with great ceremony, garlands of roses and woodroof being worn during the observance. In some parts of England the country people often sing the following distich:

"Barnaby Bright! Barnaby Bright!
The longest day and the shortest night."

and the ceremonious greetings are continued until the end of the month or beginning of July.

In 1294, Roger Bacon, the illustrious philosopher, died, at the age of seventy-eight; and in 1793, William Robertson, D.D., the distinguished historian, died in his seventy-second year.

THE TWELFTH DAY.—In 1759, died William Collins, the poet, who was supposed to be insane a short time before his death.

THE THIRTEENTH DAY.—In 1790, monastic establishments were suppressed in France; and in 1817, died Richard Lovell Edgeworth, an ingenious mechanical philosopher and popular writer, well known as the father and literary associate of Maria Edgeworth, the authoress of "Practical Education," and many other excellent works. In 1823, Robert Bowman, of Irthington, near Carlisle, died at the age of one hundred and eighteen years. His life was laborious; he had measles when young, and hooping-cough when upwards of one hundred years old; he never took medicine, but fed himself chiefly upon potatoes, bread, hasty pudding, broth, and occasionally a little meat. He never used tobacco, snuff, or

fermented liquors, thereby affording an excellent example to the young men of the present day.

THE FOURTEENTH DAY.—In 1645, the battle of Naseby was fought between the Royalists under Charles I., and the Parliament troops under Fairfax, when the former were routed, and all the artillery and ammunition seized; and in 1800, the battle of Marengo was fought.

THE FIFTEENTH DAY is dedicated to St. Vitus, who was a Sicilian martyr, under Diocletian. In papal times, fowls were offered on the festival of this saint to avert the disease called St. Vitus's dance, and it is commonly asserted that if it rains on this day—as upon St. Swithin's day—that rain will fall for a considerable time afterwards. There is a tradition, that after St. Vitus and his companions were martyred, their heads were enclosed in a church wall, and forgotten, so that no one knew where they were, until the church was repaired, when the heads were found, and the church bells began to sound of themselves; other extraordinary miracles were ascribed to the heads.

In 1826, the corps of Janissaries were abolished; and in 1844, Thomas Campbell, the poet, died at Boulogne, aged sixty-seven. He was the author of the "Pleasures of Hope," and many other works, some of which were prose; he also edited the "New Monthly Magazine" for several years. The following beautiful piece will serve as a specimen of his style:

IMMORTALITY OF THE SOUL.

This spirit shall return to Him
That gave its heavenly spark;
Yet think not, sun, it shall be dim
When thou thyself art dark!
No! it shall live again, and shine
In bliss unknown to beams of thine,
By Him recalled to breath
Who captive led captivity,
Who robbed the grave of victory,—
And took the sting from death!

THE SIXTEENTH DAY.—In 1722, John Churchill, the great Duke of Marlborough, died at Windsor-lodge, in his seventy-third year; and in 1743, the famous battle of Dettingen, in Germany, was fought, when the French army were routed by the British and allied troops, commanded by George II. in person.

THE SEVENTEENTH DAY is dedicated to St. Alban, who suffered martyrdom in 303, and was the first Christian martyr in this island. He was converted to Christianity, by Amphialus, a priest of Caerleon, in Monmouthshire, who, flying for protection from persecution, was hospitably entertained by St. Alban, at Verulam, in Hertfordshire, now called after his name St. Albans. Amphialus, being closely pursued, made his escape, dressed in St. Alban's clothes. This, however, being soon discovered, exposed St. Alban to the fury of the pagans, and he, refusing to perform the sacrifice to their gods, was first miserably tortured, and then put to death.

In 1703, John Wesley, the founder of the religious sect called after him Wesleyan Methodists, was born at Epworth; and in 1719, Joseph Addison, the well-known writer, died in his forty-eighth year. He contributed largely to the "Tatler," "Guardian," and "Spectator."

THE EIGHTEENTH DAY.—In 1805, Arthur Murphy, the dramatic author, died at Knightsbridge, near London, in the seventy-eight year of his age. He wrote "Three Weeks after Marriage," "Know your own Mind," "All in the Wrong," &c.; and in 1815, was fought the ever memorable battle of Waterloo, when the illustrious Wellington defeated Napoleon Buonaparte.

THE NINETEENTH DAY.—In 1215, the Barons compelled the arbitrary and subtle King John of England to sign the MAGNA CHARTA, or GREAT CHARTER, at Runnymede, a meadow between Staines and Windsor; in 1820, died Sir Joseph Banks, the distinguished naturalist, in his seventy-seventh year; and in 1849, the Britannia Tubular Bridge* was floated to its destination.

THE TWENTIETH DAY is remarkable for being the day on which the translation of Edward, King of the West Saxons, took place. In 978, Edward being barbarously murdered by his mother-in-law, was first buried at Wareham, without any solemnity; but after three years, was carried by Alferns to the minster of Shrews-

bury, and there interred with great pomp. In 1743 was born Anna Lætitia Barbauld, the celebrated authoress. In 1837, King William IV. died at Windsor Castle, when nearly seventy-two years of age; and on the same day her present majesty, Queen Victoria, succeeded to the throne.

THE TWENTY-FIRST DAY is the longest day in the year. In 1653, the celebrated architect, Inigo Jones, died, aged eighty years.

THE TWENTY-SECOND DAY.—In 1714, died Matthew Henry, the author of the "Exposition of the Bible," in the fifty-second year of his age; and in 1527, died the celebrated Niccolo Machiavelli, aged fifty-eight years, known as the author of the "Discorsi sulla prima Decca di Tito Livio," and many other works and fragmentary papers.

THE TWENTY-THIRD DAY.—In 1770, died Mark Akenside, the poet, author of the "Pleasures of Imagination," &c., aged forty-nine.

The eve of this day is called "Midsummer Eve," which is kept with various ceremonies in different parts of England; bonfires being lighted, and the doors of the houses decorated with St. John's wort, long-fennel, green-birch, flowers, candles and lamps, which are kept burning all night.

THE TWENTY-FOURTH DAY is commonly called *St. John's Day*, being held in commemoration of the nativity of John the Baptist, who was beheaded by the stratagem of the wife of Herod.

In 1643, died John Hampden, the patriot, aged forty-nine years.

THE TWENTY-FIFTH DAY.—In 1314 was fought the battle of Bannockburn, which placed Robert Bruce on the throne of Scotland, and was attended with such frightful slaughter on the side of the English.

THE TWENTY-SIXTH DAY.—In 1541, Francis Pizarro, the conqueror of Peru, was assassinated at mid-day in his palace at Lima, the capital of Peru, in South America; and in 1830, died George IV.

THE TWENTY-SEVENTH DAY.—In 1777, was executed, for forgery, William Dodd, LL.D.

THE TWENTY-EIGHTH DAY.—In 1577, Peter Paul Rubens, the most celebrated painter of the Flemish school, was born

* For a description of this wonder and triumph of science, see *Family Friend*, Vol. 3, New Series, page 324.

at Cologne. His "Village Fête," in the Louvre, and his "Battle of the Amazons," and "Last Judgment," at Munich, are considered by many judges as his best paintings.

THE TWENTY-NINTH DAY is dedicated to *St. Peter*, and is kept with great pomp at Rome, being a high festival of the Roman Catholic Church. At Rome the Church of *St. Peter's* is beautifully illuminated with thousands of lamps, eighty men being employed solely for that purpose, and the expense being about 1000 crowns for two nights, or 700 for one. In 1712, Jean Jacques Rousseau, one of the most eloquent writers of his age, was born at Geneva.

THE THIRTIETH DAY.—In 1474, the first book printed in England was completed on this day by Caxton, and was called "The Game and Play of the Chesse;" and in 1663, the Conventicle Act was passed.

ORFILA.

This celebrated chemist, who died lately at Paris, somewhat aged, was a Spaniard by birth, and was a native of the Island of Minorca, and born in 1787. For a long time he was at the head of all the chemists in the world in Toxicology. He was naturalized in France in 1818, and in 1824 his learning and taste were so appreciated in Paris, that he was appointed to the chair of Chemistry in the Medical School, which he filled until he died on the 4th of March, in the present year. He was a good lecturer, and very eloquent. He published a treatise on poisons as early as 1812. The amount of poisoning in Spain, perhaps, led his mind early in that direction. His first work he successively enlarged and heightened by numerous other works relating to Toxicology, Medical Chemistry, and Legal Medicine. His "Elements of Legal Medicine," which has passed through six editions, his published "Lectures on Medical Jurisprudence," and the "Juridical Exhumations," and some others of his writings, form a body of medical jurisprudence, quoted as supreme authority in the criminal tribunals here. All the physical causes, indications, and effects of death by

violence, are described and explained, and their analogies with those of natural death marked out.

He was consulted in every case of poisoning which took place in Paris for many years, his opinions were implicitly relied upon in every case, and the celebrated poisoning case of *M. Lafarge*, the accounts of which were published along with Orfila's investigations in the newspapers a few years ago, has rendered his name familiar to all. His was one of those complete minds whose faculties may be applied with equal success to a diversity of objects.

His administrative talents were excellent; he was a fine singer, and understood engineering. One day at a general meeting of the French Northern Railway, a discussion arose among the principal men charged with the financial management of their great enterprise. The question in debate was surrounded with difficulties. Orfila presented his view, and proposed his solution of it. The banker Rothschild, a chief manager of the Company, immediately begged the Professor to become one of its directors. It was while returning home in the rain, from one of their meetings, that he felt the first symptoms of the malady that so soon put an end to his career of active usefulness. It is also said that his health had been injured by exhalations from the poisons with which he experimented. Strong and true to the end, the final effort of his dying will was expressed in an order for the post-mortem examination of his body—his last contribution to the progress of science. He left 120,000 francs to found prizes for the solution of questions most important to the advancement of Toxicology, and of medicine generally.

SPIDER'S THREAD.—Austrian papers state that a merchant of Vienna has lately presented to the Industrial Union of that capital, the details of a series of experiments made by him to manufacture spider's thread into woven tissues. The thread is wound on a reel, and two dozen spiders produce, in six minutes, a beautiful and delicate thread, two thousand feet in length. The stuffs manufactured are spoken of as being far superior to those of silk in beauty and delicacy of fabric.

NATURAL PHILOSOPHY.

THE SCREW.—CONTINUED.

WHEN the thread of a screw works in the teeth of a wheel, as shown in Fig. 180, it constitutes an endless screw. An important use of this contrivance is in the engine for dividing graduated circles. The screw is also used to produce slow motions, or to measure, by the advance of its point, minute spaces. In the spherometer, represented in Fig. 5, page 4, we have an example of its use.

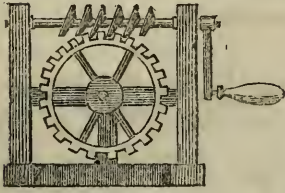


Fig. 180.

For all these purposes where slow motions have to be given, or minute spaces divided, the efficacy of the screw will increase with the closeness of its thread. But there is soon a practical limit attained; for, if the thread be too fine, it is liable to be torn off. To avoid this, and to attain those objects almost to an unlimited extent, Hunter's screw is often used. It may be understood from Fig. 181. It consists of a screw, working in a nut, *a b*. To a moveable piece, *e*, a second screw, *c*, is affixed. This screw works in the interior of *a*, which is hollow, and in which a corresponding thread is cut. While, therefore, *a* is screwed downward, the threads of *c* pass upward, and the moveable piece, *e*, advances through a space which is equal to the difference of the breadth of the two screws. In this way very slow or minute motions may be obtained with a screw, the threads of which are very coarse.

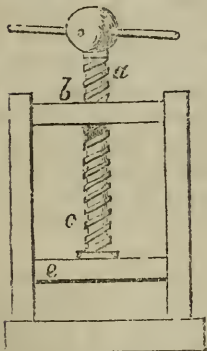


Fig. 181.

[Sometimes the lever is inserted into, or passes through, the nut into which the screw is inserted, as in Fig. 182. In this case, the nut forces the screw upwards or downwards, according to circumstances.—W. T. K.]

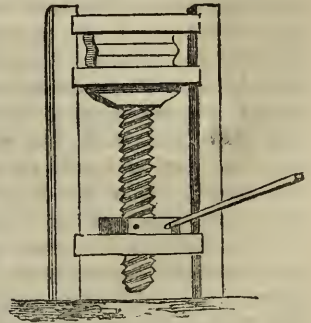


Fig. 182.

CHAPTER XXX.

OF PASSIVE OR RESISTING FORCES.

Difference between the Theoretical and Actual Results of Machinery.—Of Impediments to Motion.—Friction.—Sliding and Rolling Friction.—Co-efficient of Friction.—Action of Unguents.—Resistance of Media.—General Phenomena of Resistance.—Rigidity of Cordage.

It has already been stated, in the foregoing Chapters, that the properties of machinery are described without taking into account any of those resisting agencies which so greatly complicate their action. The results of the theory of a machine in this respect differ very widely from its practical operation. There are resisting forces

or impeding agencies which have thus far been kept out of view. We have described levers as being inflexible, the cords of pulleys as perfectly pliable, and machinery, generally, as experiencing no friction. In the case of one of the powers, it is true that this latter resisting force must necessarily be taken into account; for it is upon it that the efficacy of the wedge chiefly depends.

So, too, in speaking of the motion of projectiles, it has been stated that the parabolic theory is wholly departed from, by reason of the resistance of the air; and that not only is the path of such bodies changed, but their range becomes vastly less than what, upon that theory, it should be. Thus, a 24-pound shot, discharged at an elevation of 45° , with a velocity of 2,000 feet per second, would range a horizontal distance of 125,000 feet were it not for the resistance of the air; but through that resistance its range is limited to about 7,300 feet.

Of these impediments to motion or passive or resisting forces, three leading ones may be mentioned. They are, 1st, friction; 2nd, resistance of the media moved through; 3rd, rigidity of cordage.

OF FRICTION.

Friction arises from the adhesion of surfaces brought into contact, and is of different kinds—as *sliding friction*, when one surface moves parallel to the other; *rolling friction*, when a round body turns upon the surface of another.

By the measure of friction, we mean that part of the weight of the moving body which must be expended in overcoming the friction. The friction which expresses this is termed the co-efficient of friction. Thus, the co-efficient of sliding friction in the case of hard bodies, and when the weight is small, ranges from one seventh to one third.

["We are not to consider friction as a *small* force, slightly modifying the effects of other agencies. On the contrary, its amount is in most cases very great. When a body lies loose on the ground, the friction is equal to one third or one half, or in some cases of bodies supported by oblique pressure, the amount is far more enormous. In the arch of a bridge, the friction which is called into play between two of the vaulting stones, may be equal to the whole weight of the bridge. In such cases this conservative force is so great, that the common theory, which neglects it, does not help us even to guess what will take place. According to the theory, certain forms of arches only will stand; but in practice almost any form will stand, and it is not easy to construct a model of a bridge which will fall.

"We may see the great force of friction in the *brake*, by which a large weight running down a long inclined plane has its motion moderated and stopped; in the windlass, where a few coils of the rope round a cylinder sustain the stress and weight of a large iron anchor; in the mode of raising large blocks of granite by an iron rod driven into a hole in the stone. Probably no greater forces are exercised in any processes in the arts than the force of friction; and it is always employed to produce rest, stability, moderate motion. Being always ready and never wearied, always at hand, and augmenting with the exigency, it regulates, controls, subdues all motions; counteracts all other agents; and, finally, gains the mastery over all other terrestrial agencies, however violent, frequent, or long-continued. The perpetual action of all other terrestrial forces appears, on a large scale, only as so many interruptions of the constant and stationary rule of friction."—"Astronomy and General Physics," by Professor Whewell.]

It has been proved by experiment that friction increases as the weight or pressure increases, and as the surfaces in contact are more extensive, and as the roughness is greater. With surfaces of the same material it is nearly proportional to the pressure. The time which the surfaces have been in contact appears to have a considerable influence, though this differs much with surfaces of different kinds. As a general rule, similar substances give rise to greater friction than dissimilar ones.

On the contrary, friction diminishes as the pressure is less, as the polish of the moving surfaces is more perfect, and as the surfaces in contact are smaller. It may also be diminished by anointing the surfaces with some suitable unguent or greasy

material. Among such substances as are commonly used are the different fats, tar, and black lead. By such means, friction may be reduced to one fourth.

Of the friction produced by sliding and rolling motions, the latter, under similar circumstances, is far the least. This partly arises from the fact that the surfaces in contact constitute a mere line, and partly because the asperities are not abraded or pushed aside before motion can ensue. The nature of this distinction may be clearly understood by observing what takes place when two brushes with stiff bristles are moved over one another, and when a round brush is rolled over a flat one. In this instance, the rolling motion lifts the resisting surfaces from one another; in the former, they require to be forcibly pushed apart.

Though, in many instances, friction acts as a resisting agency, and diminishes the power we apply to machines, in some cases its effects are of the utmost value. Thus, when nails or screws are driven into bodies, with a view of holding them together, it is friction alone which maintains them in their places. The case is precisely the same as in the action of a wedge.

RESISTANCE OF MEDIA.

A great many results in natural philosophy illustrate the resistance which media offer to the passage of bodies through them. The experiment known under the name of the guinea and feather experiment, establishes this for atmospheric air. In a very tall air-pump receiver there are suspended a piece of coin and a feather in such a way, that, by turning a button, the piece on which they rest drops, and permits them to fall to the pump-plate. Now, if the receiver be full of atmospheric air, on letting the objects fall, it will be found that, while the coin descends with rapidity, and reaches, in an instant, the pump-plate, the feather comes down leisurely, being buoyed up by the air, and the speed of its motion resisted. But if the air is first extracted by the pump, and the objects allowed to fall in vacuo, both precipitate themselves simultaneously with equal velocity, and accomplish their fall in equal times.

In the vibrations of a pendulum, the final stoppage is due partly to friction and partly to this cause. And in the case of motions taking place in water, we should, of course, expect to find a greater resistance arising from the greater density of that liquid.

The resisting force of a medium depends upon its density, upon the surface which the moving body presents, and on the velocity with which it moves.

Water, which is 800 times more dense than air, will offer a resistance 800 times greater to a given motion. Of the two mills represented in Fig. 35 (page 65), that which goes with its edge first runs far longer than that which moves with its plane first. We are not, however, to understand that the effect of the medium, on a body moving through it, increases directly as the transverse section of the body; for a great deal depends upon its figure. A wedge, going with its edge first, will pass through water more easily than if impelled with its back first, though, in both instances, the area of the transverse section is of course the same. It is stated that spherical balls encounter one fourth less resistance from the air than would cylinders of equal diameter; and it is upon this principle that the bodies of fishes and birds are shaped, to enable them to move with as little resistance as may be through the media they inhabit.

The resistance of a medium increases with the velocity with which a body moves through it, being as the square of the velocity, so long as the motion is not too rapid; but when a high velocity is reached, other causes come into operation, and disturb the result.

As with friction, so with the resistance of media, a great many results depend on this impediment to motion; among such may be mentioned the swimming of fish through water, and the flight of birds through the air. It is the resistance of the air which makes the parachute descend with moderate velocity downward, and causes the rocket to rise swiftly upward.

RIGIDITY OF CORDAGE.

In the action of pulleys, in machinery in which the use of cordage is involved, the

rigidity of that cordage is an impediment to motion. When a cord acts round a pulley, in consequence of imperfect flexibility, it obtains a leverage on the pulley, as may be understood from Fig. 183, in which let C K D be the pulley working on a pivot at O : let A and B be weights suspended by the rope, A C K D B. From what has been said respecting the theory of the pulley, the action of the machine may be regarded as that of a lever, C O D, with equal arms, C O, O D. Now, if the cord were perfectly inflexible, on making the weight, A, descend by the addition of a small weight to it, it would take the position at A', the rope being a tangent to the pulley at C'; at the same time B, ascending, would take the position B', its cord being a tangent at D'. From the new positions, A' B', which the inflexible cord is thus supposed to have assumed, draw the perpendiculars, A' E, B' F, then will O E, O F, represent the arms of the lever on which they act—a diminished leverage on the side of the descending, and an increased leverage on the side of the ascending weight is the result.

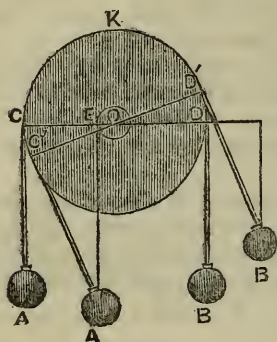


Fig. 183.

In practice, the result does not entirely conform to the foregoing imaginary case, because cords are, to a certain extent, flexible. As their pliability diminishes, the disturbing effect is greater. The degree of inflexibility depends on many casual circumstances, such as dampness or dryness, or the nature of the substance of which they are made. Inflexibility increases with the diameter of a cord, and with the smallness of the pulley over which it runs.

UNDULATORY MOTIONS.

CHAPTER XXXI.

OF UNDULATIONS.

Origin of Undulations.—Progressive and Stationary Undulation.—Course of a progressive Wave.—Nodal Points.—Three different kinds of Vibration.—Transverse Vibration of a Cord.—Vibrations of Rods.—Vibrations of elastic Planes.—Vibrations of Liquids.—Waves on Water.—Law of the Reflection of Undulations.—Applied in the case of a Plane, a Circle, an Ellipse, a Parabola.—Case of a Circular Wave, on a Plane.—Interference of Waves.—Inflexion of Waves.—Intensity of Waves.—Method of Combining Systems of Waves.

WHEN an elastic body is disturbed at any point, its particles gradually return to a position of rest, after executing a series of vibratory movements. Thus, when a glass tumbler is struck by a hard body, a tremulous motion is communicated to its mass, which gradually declines in force until the movement finally ceases.

In the same manner a stretched cord, which is drawn aside at one point, and then suffered to go, is thrown into a vibratory or undulatory movement; and, according as circumstances differ, two different kinds of undulation may be established, 1st, progressive undulations; 2nd, stationary undulations.

In progressive undulations the vibrating particles of a body communicate their motion to the adjacent particles; a successive propagation of movement, therefore, ensues. Thus, if a cord is fastened at one end, and the other is moved up and down, a wave or undulation, $m D n E o$, Fig. 184, is produced. The part, $m D n$, is the elevation of the wave, D being the summit, $n E o$, is the depression, E being the lowest point, $D p$ is the height, $q E$ the depth, and $m o$ the length of the wave.

But, under the circumstances here considered, the moment this wave has formed, it passes onward, and successively assumes the positions indicated at I, II, III. When it has arrived at the other end of the cord, it at once returns with an inverted motion, as shown at IV and V. This, therefore, is a progressive undulation.

Again, instead of the cord receiving one impulse, let it be agitated equally at equal

intervals of time ; it will then divide itself, as shown in Fig. 185, into equal elevations and depressions with intervening points, m n , which are at rest. These are stationary undulations, and the points are called nodal points.

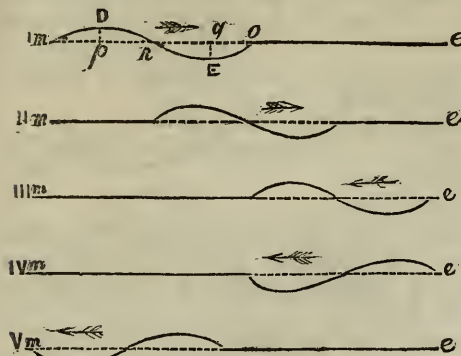


Fig. 184.

There are three different kinds of vibrations into which a stretched string may be

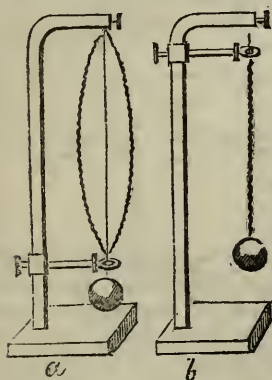


Fig. 186.

thrown : transverse, longitudinal, and twisted. These may be illustrated by the instrument represented at Fig. 186. It consists of a piece of spirally-twisted wire, stretched from a frame by a weight. If the lower end of the wire be secured by a clamp, on pulling the wire in the middle, and then letting it go, it executes transverse vibrations, *a*. If the weight be gently lifted, and then let fall, the wire performs longitudinal vibrations ; and if the weight be twisted round, and then released, we have rotatory vibrations, *b*.

If we take a string, *a* *b*, Fig 187, and having stretched it between two fixed points, *a* and *b*, draw it aside, and then let

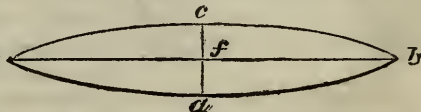


Fig. 187.

it go, it executes transverse vibrations, as has already been described. The cause of its motion, from the position

we have stretched it to, is its own elasticity. This makes it return from the position, *a c b*, to the straight line, *a f b*, with a continually accelerated velocity ; but when it has arrived in *a f b*, it cannot stop there, its momentum carrying it forward to *a d b*, with a velocity continually decreasing. Arrived in this position, it is, for a moment, at rest ; but its elasticity again impels it as before, but in the reverse direction to *a f b* ; and so it executes vibrations on each side of that straight line, until it is finally brought to rest by the resistance of the air. One complete movement, from *a c b* to *a d b* and back, is called a vibration, and the time occupied in performing it the time of an oscillation.

The vibratory movements of such a solid are isochronous, or performed in equal lines. They increase in rapidity with the tension—that is, with the elasticity—being as the square root of that force. The number of vibrations in a given time is inversely as the length of the string, and also inversely as its diameter.

The vibrations of solid bodies may be studied best under the division of cords, rods, planes, and masses. The laws of the vibrations of the first are such as we have just explained.

In rods the transverse vibrations are isochronous, and in a given time are in number inversely as the squares of the lengths of the vibrating parts. Thus, if a rod makes two vibrations in one second, if its length be reduced to half, it will make four times as many—that is, eight ; if to one-fourth, sixteen times as many—that is, thirty-two,

The agents by which undulatory movements are established are chiefly elasticity and gravity. It is the elasticity of air which enables it to transmit the vibratory motions



Fig. 185.

which constitute sound, and, for the same reason, steel rods and plates of glass may be thrown into musical vibrations. In the case of threads and wires, a sufficient degree of elasticity may be given by forcibly stretching them. Waves on the surface of liquids are produced by the agency of gravity.

&c. The motion performed by vibrating-rods is often very complex. Thus, if a bead be fastened on the free extremity of a vibrating steel rod, Fig. 188, it will exhibit in its motions a curved path, as is seen at *c*. Rods may be made to exhibit nodal points. The space between the free extremity and the first nodal point is equal to half the length contained between any two nodal points, but it vibrates with the same velocity. Thus, *a*, Fig. 189, being the fixed, and *b* the free end of such a rod, the part between *b* and *c*, is half the distance, *c c'*.



Fig. 188. A B is the vibrating plane. The dimensions of these spaces are regulated in the same way as the internodes of vibrating-rods—that is, the outside ones, *a b a b*, are always half the size of the interior. The relation of these spaces, and positions of the nodal lines, may be determined by making a glass-plate covered with dry sand vibrate.

[When we wish to make plates vibrate, we use a vice, such as is shown in Fig. 191, and having placed the plate between the cylinder, *a*, and the screw, *b*, both of which are tipped with leather or cork, the latter is turned until the plate is fixed firmly; and then, when a bow is drawn along the edge of the plate once or twice, it vibrates sufficiently to cause the sand upon its surface to rise and fall during the tone produced, and to accumulate upon the nodal lines, so as to form the sound-figures, as they were called by Chladni, their discoverer. These figures vary in form according as the bow is moved more or less rapidly, or violently, and the point of support and action are changed.—W. T. K.]

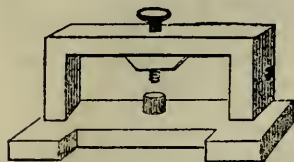


Fig. 191.



Fig. 189.

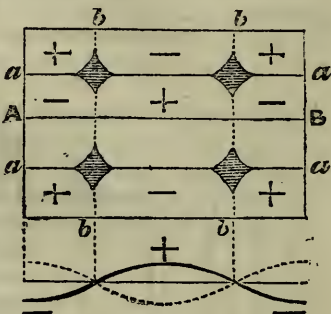


Fig. 190.

form the sound-figures, as they were called by Chladni, their discoverer. These figures vary in form according as the bow is moved more or less rapidly, or violently, and the point of support and action are changed.—W. T. K.]

When the surface of a liquid, as water, is touched, a wave arises at the disturbed point, and propagates itself into the unmoved spaces around, continually enlarging as it goes, and forming a progressive undulation. [This is easily proved by filling a tumbler with water, and letting a small piece of paper, a grain of corn, or any small object fall into it; or by throwing a stone into a smooth-surfaced pond.—W. T. K.]

A number of familiar facts prove that the apparent advancing motion of the liquid on which waves are passing is only a deception. Light pieces of wood are not hurried forward on the surface of water, but merely rise up and sink down alternately as the waves pass. The true nature of the motion is such that each particle, at the surface of the undulating liquid, describes a circle in a vertical plane, and in the direction in which the wave is advancing, the movement being propagated from each to its next neighbour, and so on. And as a certain time must elapse for this transmission of motion, the different particles will be describing different points of their circular movement at the same moment. Some will be at the highest part of their vertical circle when others are in an intermediate position, and others at the lowest, giving rise to a wave, which advances a distance equal to its own length, while each particle performs one entire revolution.

[“The force by which the water-waves are propagated is gravity: for, if from any cause an elevation or a depression be produced on the horizontal surface of the water, the gravity of the separate particles of water will endeavour to restore the disturbed horizontal plane, by which means an oscillatory motion is produced, which, by degrees,

is propagated from one particle to another.”—*Professor Müller's Physics and Meteorology, Lecture XV.*

Thus, in Fig. 192, let there be eight particles of water on the surface, $a m$, which, by some appropriate disturbance, are made to describe the verticle circles represented



Fig. 192.

at $a b c d e f g h$, moving in the direction represented by the darts, and let each one of these commence its motion one eighth of a revolution later than the one before it. Then, at any given moment, when the first one, a , is in the position marked a , the second, b , will be in the position marked 7 , c at 6 , d at 5 , e at 4 , f at 3 , g at 2 , h at 1 ; but m will not yet have begun to move. If, therefore, we connect these various points, $a 7 6 5 4 3 2 1 m$, together by a line, that line will be on the surface of the wave, the length of which is $a m$, the height or depth of which is equal to the radius of the circle of each particle's revolution, and the time of passage through the length of one wave will be equal to the time of the revolution of each particle.

By a ray of undulation we mean a line drawn from the origin of a wave in the direction in which any given point of it is advancing. A wave is said to be incident when it falls on some resisting surface, and reflected when it recoils from it. Incident rays are those drawn from the origin towards the resisting surface, and reflected rays those expressing the path of the undulating points after their recoil. The angle of incidence is the angle which an incident wave makes with a perpendicular drawn to the surface of impact; the angle of reflection is the angle made by the reflected ray and the same perpendicular. Thus, let i be a resisting surface of any kind, $n i$, an incident ray, $i p$, a perpendicular to the point of impact of the wave, $i d$ the reflected ray. Then $n i p$ is the angle of incidence, and $d i p$ the angle of reflection.

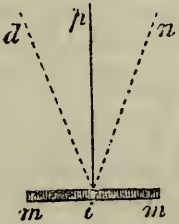


Fig. 193.

The general law for the reflection of waves is, that “all the points in a wave will be reflected from the surface of the solid under the same angle at which they struck it.”

If, therefore, parallel rays fall on a plane surface, they will be reflected parallel; if diverging, they will be reflected diverging; and if converging, converging.

If a circular wave advances from the centre of a circular vessel, each ray falls perpendicularly on the surface of the vessel, and is reflected perpendicularly—that is to say, back in the line along which it came. The waves, therefore, all return to the centre from which they originated.

If undulations proceed from one focus of an ellipse, they will, after reflection, converge to the other focus.

If a surface be a parabola, rays diverging from its focal point, a , will, after reflection, pass in parallel lines, $b d, c d, e d$. Or if the rays impinge in parallel lines, they will, after reflection, converge to the focus.

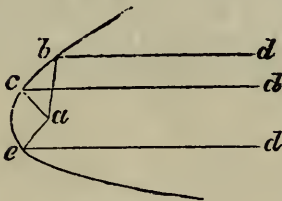


Fig. 194.

When diverging rays of a circular wave fall upon a plane surface, their path, after reflection, is such as

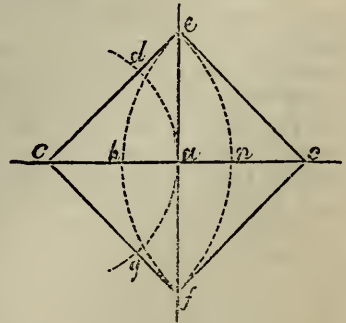


Fig. 195.

it would have been had they originated from a point on the opposite side of the plane, and as far distant as the point of origin itself. Thus, let c be the origin

of a circular wave, $d a g$, which impinges on a plane, $e f$, after reflection this wave will be found at $e h f$, as though it had originated at c' , a point on the opposite side of $e f$, as far as c , in front of it. Now, the parts of the circular wave, $d a g$, do not all impinge on the plane at the same time, but that at a , which falls perpendicularly, impinges first, and is first reflected; the ray at d has to go still through the distance, $d e$, before reflection takes place; but, in this space of time, the ray at a will have returned back to h ; and, in the same way, it may be shown that the intermediate rays will have returned to intermediate positions, and be found in the line $e h f$, symmetrically situated, with respect to the line $e n f$, in which they would have been had they not fallen on the plane. And it further follows that the centre, c' , of the circular wave, $e h f$, is as far from $e f$ as is the centre, c , of the circular wave, $d a g$, but on the opposite side.

By interference we mean that two or more waves have encountered one another, under such circumstances as to destroy each other's effect. If on water two elevations or two depressions coincide, they conspire; but when an elevation coincides with a depression, interference takes place, and the surface of the fluid remains plane. Waves which have thus crossed one another continue their motion unimpaired.

If two systems of waves of the same length encounter each other, after having come through paths of *equal* length, they will not interfere; nor will they interfere, even though there be a difference in the length of their paths, provided that difference be equal to one whole wave, or two, or three, &c.

But if two systems of waves of equal length encounter each other after having come through paths of *unequal* length, they will interfere, and that interference will be complete when the difference of the paths through which they have come is half a wave, or one and a half, two and a half, three and a half, &c.

When a circular wave impinges on a solid in which there is an opening, as at a, b ,

Fig. 196, the wave passes through, and is propagated to the spaces beyond; but other waves arise from $a b$, as centres, and are propagated as represented at $c d e f$. This is the *inflection* of waves, and these new waves intersecting one another and the primitive one, give rise to interferences.

We have now traced the chief phenomena of vibrations in solids and on the surface of liquids. It remains to do the same for elastic bodies, such as gases.

When any vibratory movement takes place in atmospheric air, the impulse communicated to the particles causes them to recede a certain distance, condensing those that are before them; the impulse is finally overcome by the resistance arising from this condensation. There, therefore, arises a sphere of air, the superficies or shell of which has a maximum density. Reaction

now sets in, the sphere contracts, and the returning particles come to their original positions. But as a disturbance on the surface of a liquid gives origin to a progressive wave, so does the same thing take place in the air.

By the intensity of vibration of a wave we mean the relative disturbance of its moving particles, or the magnitude of the excursions they make on each side of their line of rest. Thus, on the surface of water we may have waves "mountains high," or less than an inch high; the intensity of vibration in the former is correspondingly greater than in the latter case.

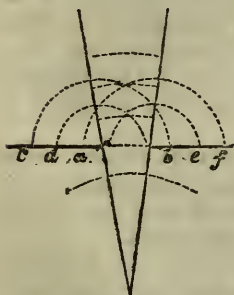


Fig. 196.

SYSTEM OF ELOCUTION.

GESTURE.

The qualities of Gesture, and the Gesture suited to different modes of Public Speaking.—The different qualities which constitute the perfection of gesture, and their opposite imperfections, are as follows:

1. Magnificence. 2. Boldness. 3. Energy. 4. Variety. 5. Simplicity. 6. Grace. 7. Propriety. 8. Precision.

1. *Magnificence of Gesture.*—This is effected by detaching the elbow completely from the body, and unfolding the whole oratorical weapon. In magnificent gesture, the action is flowing and unconstrained; the preparations are made in graceful curves; the transitions are easy, and the accompaniments, in all respects, illustrative of the principal action. The motions of the head are free, and the inflections of the body manly and dignified. The action of the lower limbs is decisive, and a considerable space is traversed with firmness and with force.

The opposite imperfections are short and constrained gestures, rigidity of the joints, and stiffness of the body, with short steps, and doubtful or timid movements.

2. *Boldness of Gesture.*—This arises from that elevated courage and self-confidence which ventures to hazard any action, however unusual, which is productive of a grand or striking effect. In this sort of gesture, unexpected positions, elevations and transitions, surprise at once by their novelty and grace, and thus illustrate or enforce the ideas of the speaker with irresistible effect.

The opposite imperfection is tameness.

3. *Energy of Gesture.*—This consists in the firmness and decision of the whole action; and in the precision of the stroke of the gesture, which aids the emphasis of the voice.

The opposite imperfections are feebleness and indecision.

4. *Variety of Gesture.*—This consists in the application of different, but appropriate gestures, to the same, or analogous sentiments, so as to avoid recurring too frequently to one favourite gesture, or set of gestures.

The opposite imperfection is monotony of gesture, analogous to that of the voice.

5. *Simplicity of Gesture.*—This is such a character of gesture as appears the natural result of the situation and sentiments; which is neither carried beyond the just extent of the feeling, through affectation of variety, nor falls short of it through want of confidence.

The opposite imperfection is affectation.

6. *Grace of Gesture.*—This is the result of all other perfections, arising from a dignified self-possession of mind, and the power of personal exertion, practised into facility after the best models, and according to true taste. To the more particular attributes of this quality we have already alluded.

The opposite imperfection is awkwardness.

7. *Propriety of Gesture, called also Truth of Gesture, or Natural Gesture.*—This consists in the judicious use of gestures best suited to illustrate or to express the sentiment. Propriety of gesture is generally founded on some natural connection between the sentiment and the action. *Significant* gestures are strictly connected with the sentiment.

The opposite imperfections are false, contradictory, or unsuitable gestures.

8. *Precision, or Correctness of Gesture.*—This arises from the just preparation, due force, and the correct timing of the action: when the preparation is neither too much abridged, nor too pompously displayed; when the stroke of the gesture is made with such a degree of force as suits the character of the sentiment; and when it is correctly marked on the precise syllable to be enforced. Precision of gesture gives the same effect to action, as neatness of articulation gives to speech.

The opposite imperfections are the indecision, uncertainty, and incorrectness arising from vague and sawing gestures, which, far from illustrating, render doubtful the sense of the sentiments which they accompany, and distract the spectator.

There are three general modes of public speaking, each of which requires a different style of gesture; namely, 1. The Epic. 2. The Rhetorical. 3. The Colloquial.

1. *Epic Gesture* demands every natural and acquired power on the part of the speaker: to it belong Magnificence, Boldness, Energy, Variety, Simplicity, Grace,

Propriety, and Precision. The compositions which require epic gesture, in delivery, are tragedy, epic poetry, lyric odes, and sublime description.

2. *Rhetorical Gesture* requires, principally, Energy, Variety, Simplicity, and Precision. Grace is desirable; Magnificence is rarely wanting, but may sometimes have place. Propriety, in a limited sense, should be observed. Boldness is inadmissible; because the orator is not, like the player, subjected to any unexpected circumstances. He is not, therefore, at liberty to express surprise, or any other passion, by bold gestures or attitudes.

3. *Colloquial Gesture*, when concerned in the higher scenes of polite life, requires, principally, Simplicity and Grace; Precision will follow of course; it may occasionally demand something of Energy and Variety. Magnificence and Boldness are inadmissible.

The gesture of the public speaker must vary considerably with the different circumstances of his situation, of his sentiments, and of his audience. If the mere information or instruction of his audience be his sole object, as when the evidences of religion and the grounds of Christian duties are to be explained from the pulpit, or when the details of calculation and finance are to be laid before meetings, or when facts are weighed and laws are argued in the courts of justice, his gestures should be of that class which is called *discriminating* gestures. These he should exercise with simplicity and precision. He should strip them of all the parade of preparation, and of the graces of transition, and give them only that degree of variety which shall guard them against disgusting sameness. This is far removed from theatrical gesture; it rather approaches the colloquial style. Nothing could be more incongruous than for a public speaker, in either of the foregoing situations, to introduce the parade and magnificence of theatrical gesture. The charge which is sometimes made against public speakers, of being theatrical in their gesture, probably arises more from some unsuitableness in their manner to the matter, than from anything of uncommon majesty, boldness, or grace in their action.

When the public speaker aims at per-

suasion, as in discourses from the pulpit for public charities, or on extraordinary occasions at meetings, or at the bar, when the advocate desires to influence the opinions of a jury, he will naturally use more graceful, more flowing, and more varied gesture. But he should not fall into the action of the theatre. He may be graceful, but he should be simple; he may be energetic, but he should not affect gestures too strongly significant, much less attempt surprise by attitudes. All his gestures should be regulated by manly decorum, suitable to his situation, to the character of his hearers, and to the just expression of his sentiments.

Significant Gestures.—The most important of the significant gestures are the following:

The Head and Face.—The hanging down of the head denotes shame or grief.

The holding of it up, pride or courage.

To nod forwards implies assent.

To toss the head back, dissent.

The inclination of the head implies diffidence or languor.

The head is averted, in dislike or horror.

It leans forward, in attention.

The Eyes.—The eyes are raised, in prayer.

They weep, in sorrow.

They burn, in anger.

They are downcast or averted, in shame or grief.

They are cast on vacancy, in thought.

They are cast in various directions, in doubt and anxiety.

The Arms.—The placing of the hand on the head, indicates pain or distress.

On the eyes, shame or sorrow.

On the lips, an injunction of silence.

On the breast, an appeal to conscience.

The hand is waved, or flourished, in joy or contempt.

Both hands are held supine, or they are applied, or clasped, in prayer.

Both are held prone, in blessing.

They are clasped, or wrung, in affliction.

They are held forward, and received, in friendship.

The Body.—The body, held erect, indicates steadiness and courage.

Thrown back, pride.

Stooping forward, condescension or compassion.

Bending, reverence or respect.

Prostration, the utmost humility or abasement.

The Lower Limbs.—The firm position of the lower limbs signifies courage, or obstinacy.

Bended knees indicate timidity, or weakness.

The lower limbs advance, in desire or courage.

They retire, in aversion or fear.

Start, in terror.

Stamp, in authority or anger.

Kneel, in submission and prayer.

These are a few of the simple gestures which may be termed significant.

Grace.—“Grace,” said Lord Kames, “may be defined, that agreeable appearance which arises from elegance of motion, and from a countenance expressive of dignity. Expressions of other mental qualities are not essential to that appearance, but they heighten it greatly.”

The gracefulness of rhetorical action depends partly on the person, and partly on the mind. Some are so happily formed that all their motions are graceful; and some minds are so noble, that they impart genuine grace to the most uncouth forms: both these cases, however, are comparatively rare.

Grace, like the ideal beauty of the painter, and of the sculptor, is not commonly to be found in the individual living model, but to be collected from the various excellencies of the many.

Neither true grace, nor consummate eloquence, can be acquired by those who are totally deficient in natural qualifications; yet they to whom nature has not denied some portion of talents, may improve in both, precisely in proportion to the degree of their application.

The grace of oratorical action consists, chiefly, in the facility, the freedom, the variety, and the simplicity of those gestures which illustrate the discourse.

Action, to be graceful, should be performed with facility; because the appearance of great effort is incompatible with ease, which is a constituent of grace. It should also be performed with freedom: no gestures can be graceful which are either confined by external circumstances, or restrained by the mind. If an orator should address an assembly from a narrow

window, it would be in vain for him to attempt graceful gesture. Confinement, in any less degree, is proportionably injurious to grace. Thus, the crowded courts, which impede the motions of the advocate, and the enclosed pulpit, which not unfrequently conceals more than half the preacher's figure, are equally injurious to graceful action. Greece, the native soil of manly eloquence and true taste, *was not the originator of the pulpit.*

The restraint arising from diffidence is also prejudicial to grace. It has, however, this advantage—it may be effectually corrected by perseverance.

For the maintenance of grace, in rhetorical action, variety is indispensable. The iteration of the same gesture, or set of gestures, however graceful in themselves, betrays a poverty of resource which is altogether prejudicial to the speaker.

Simplicity and truth of manner, if they do not constitute grace in themselves, are inseparable from it. Gestures which are manifestly contrived for the mere display of the person, or for the exhibition of some foppery, as, for instance, a fine ring, instantly offend.

To simplicity of gesture is opposed affectation, which destroys every pretension to genuine grace. The more showy the gestures are, unless they are adapted to the subject, and to the character of the speaker, the more do they offend the judicious by their manifest affectation. When the profligate speaks of piety, the miser of generosity, the coward of valour, and the corrupt of integrity, they are only the more despised by those who know them.

The faults of manner are analogous to those of character, and almost equally disgusting: such as the assumption of dignity where there is none in the sentiment; pathos, where there is nothing interesting; vehemence in trifles, and solemnity upon common-place subjects.

It is an observation founded in fact, that the action of young children is never deficient in grace; for which two reasons may be assigned: first, because they are under no restraint from diffidence, or from any other cause, and therefore use their gestures, with all sincerity of heart, only to aid the expression of their thoughts; and, secondly, because they have few ideas

of imitation, and consequently are not deprived of natural grace by affectation, nor perverted by bad models.

The grace of action, according to Hogarth, consists in moving the body and limbs in that curve which he calls the line of beauty. When action is considered independent of language and sentiment, this definition will, perhaps, be found generally correct. Rhetorical action, however, derives its grace, not only from the actual motions of the speaker, but also from the congruity of his motions with his own character and situation, as well as with the sentiments which he delivers. The dignity which is a becoming grace in a judge, would be quaint affectation in a young advocate; and the colloquial, but graceful familiarity of action, even of the most polished society, would be highly indecorous in the pulpit. Hence, it must be admitted, according to the just maxim of Cicero and Quintilian, that *decorum* constitutes true oratorical grace; and that this *decorum* admits of great variety of action, under different circumstances. Vehement action is sometimes both decorous and graceful; so also are abrupt and short gestures, if they bear the impress of truth and suitableness. Such are the gestures of an old man when he is irritated. But the most flowing and beautiful motions, the grandest preparations, and the finest transitions of gesture, ill applied, and out of time, lose their natural character of grace, and become indecorous, ridiculous, or offensive.

In conclusion we may observe, that in the recitation of descriptions of any kind, the speaker must, in imagination, have the picture before his eyes, and each object must be disposed in the same order as if actually painted. If this imaginary picture be faulty in the composition, confused, or ill-grouped, the gesture will perplex, rather than enlighten; but, if well conceived, and well disposed in its parts, the speaker will seem to give it the interest of life by his skilful gesture and recitation; and the auditor will almost imagine that he actually contemplates all that the speaker describes. Impassioned compositions, delivered with proper feeling and expression, open, in like manner, to the view of the hearer, the internal operations of the speaker's mind.

LESSONS IN FRENCH.

THE ADJECTIVE.

Of the Superlatives, Absolute and Relative.

—The adjective is in the superlative degree of comparison, when it expresses the quality of the noun in the highest degree, or in a very high degree; hence there are two sorts of superlatives, the *absolute* and the *relative*.

The superlative absolute is made by putting *très, fort, bien, very*, before the adjective; it is called absolute, because it expresses no relation to other objects; as, Rome is a very fine city, *Rome est une très belle ville*.

The adverbs, *extremely, extrêmement, infinitely, infiniment*, are also the sign of the superlative absolute: This woman is extremely aimable, *Cette femme est extrêmement aimable*; This man is supremely happy, *Cet homme est infiniment heureux*.

The superlative relative is formed by placing the article before the comparatives, *plus, pis, moins, meilleur, pire, moindre*; it is relative, because it expresses a relation to other objects; the article must be of the same number and gender as the adjective. Paris is the finest of cities, *Paris est la plus belle des villes*; You are the smaller of the two, *Vous êtes le moins grand des deux*; He is the worst of the family, *Il est le pire de la famille, &c.*

When several adjectives in either of the superlatives qualify a noun, the adverbs, *plus, moins, fort, extrêmement, &c.*, must be repeated before every one of them, as well as the article, when the superlative is relative.

Remark.—When the adjective used in the superlative relative is placed before the noun, the article *the* is used but once; as in, Your sister is the most handsome woman I have ever seen, *Votre sœur est la plus belle femme que j'aie jamais vue*.

But if the superlative should be placed before the noun, the article *the* should be used twice before the noun and in the superlative; as, Your sister is the most accomplished woman I know, *Votre sœur est la femme la plus accomplie que je connaisse*.

Of the Place of Adjectives.—There is no absolute rule in reference to the place

of adjectives; taste and euphony are the only guides in many cases. Usage, however, has decided that some of them, on account of their origin or signification, should always follow or precede the nouns which they qualify; whilst others acquire an entirely different meaning by being placed before or after them. We will, therefore, divide the adjectives into three classes:—

(1.) Those which always follow the noun.

(2.) Those which have a different meaning by being placed before and after the noun.

(3.) Those of which the place is fixed by taste and euphony.

Of Adjectives which are invariably placed after the Noun.—(1.) Adjectives derived from past participles; as, An accomplished woman, Une femme *accomplie*; A distinguished man, Un homme *distingué*.

(2.) Adjectives expressing form, colour, taste, flavour, and sound; as, A round table, Une table *ronde*; A white house, Une maison *blanche*; Sweet wine, Du vin *doux*; An odoriferous flower, Une fleur *odoriférante*; A sonorous voice, Une voix *sonore*.

(3.) Adjectives performing the part of nouns; as, A royal palace, (a palace of a king), Un palais *royal*; The paternal tenderness (of a father), La tendresse *paternelle*; A grammatical principle (of a grammar), Un principe *grammatical*.

(4.) Adjectives expressing the point of view in which we consider things or persons; as, A necessary, possible, or impossible thing, Une chose *nécessaire, possible, impossible*; An absurd idea, Une idée *absurde*; A dangerous man, Un homme *dangereux*; A mortal disease, Une maladie *mortelle*.

Mortel is sometimes placed before the noun, but then it signifies *tedious, wearisome*; as, Three wearisome miles, Trois *mortels* milles.

(5.) Adjectives which express the state or situation of persons and things, and those which refer to habits; as, A quiet or peaceable man, Un homme *tranquille, calme*; An idle or drunken man, Un homme *oisif, ivre*; Thick or thin cloth, Du drap *épais, ou mince*.

(6.) Adjectives which express an outward or accidental modification; as, A

blind or humpbacked man, Un homme *aveugle ou bossu*; A knotty stick, Un bâton *noeux*.

(7.) Adjectives merely distinguishing objects by genus, species, or sort; as, A reasonable animal, Un animal *raisonnable*; A fruit-tree, Un arbre *fruitier*; A personal pronoun, Un pronom *personnel*.

(8.) Adjectives designating countries; as, The French army, L'armée *Française*.

Of Adjectives which sometimes precede and sometimes follow the Noun without changing their Signification.—(1.) Adjectives derived from present participles, generally follow the noun, but a great number may be placed before it; as, A fascinating woman, Une femme *séduisante*; An interesting book, Un livre *attachant*; A charming music, Une *charmante* musique; A charming country-house, Une *charmante* maison de campagne.

(2.) Adjectives which by their meaning have some analogy with the noun which they qualify, are placed before the noun, and after it if that analogy does not exist; as, A wise magistrate, Un *sage* magistrat; A wise man, Un homme *sage*.

In the first expression, there is an analogy between *wisdom* and the character of the following noun, for a magistrate is supposed to be wise—he could not be a magistrate without being so; but the word *man* does not necessarily imply the idea of wisdom, for there are many more fools than wise men; hence the place of the adjective in either case.

For the same reason we may say, Good wine, De *bon* vin; Bad bread, De *mauvais* pain; A large tree, Un *grand* arbre; A small child, Un *petit* enfant.

Remark.—In the language of passion, piety, and admiration, in poetry and metaphorical style, many of the adjectives which we have classed among those that should be placed after the noun, are elegantly placed before it; as, An amiable object, Un *aimable* objet; White hands, De *blanches* mains; Tender looks, De *tendres* regards; A wicked man, Un *méchant* homme; although there is no necessary analogy between an *object* and *amiableness*, between *looks* and *tenderness*, and *man* and *wickedness*, &c.

In speaking of a man, if we say, He is extremely miserable, Il est dans une

misère extrême, we merely intimate that his misery is great, without inferring any intention on our part to interest others in that distress, which would be the case if we should say, *Il est dans une extrême misère*.

Numerical adjectives are generally placed before the noun; but when they are used to designate a person or a thing among others of the same name, by the rank which they occupy among them, they are placed after it when speaking of persons, and indifferently, before or after, when speaking of things; as in, The disobedience of Adam was the first fault of our first parents, *La désobéissance d'Adam fut la première faute de nos premiers parens*; Louis the Twelfth and Louis the Eleventh were two French kings of a very different character, *Louis Onze et Louis Douze furent deux rois de France d'un caractère bien différent*; Volume first, *Volume premier*, or *premier volume*; Chapter tenth, *Chapitre dix*, or *dixième chapitre*.

When placed before the noun, ordinal adjectives are used; placed after, we employ the cardinal, except for the numbers *first* and *second*.

Of Adjectives which change entirely their Signification by being placed before or after certain Nouns.—We shall not mention here all the adjectives which belong to this class,—good dictionaries give the necessary information on the subject; we will only mention those which, exposing foreigners to disagreeable blunders, require their particular attention at an early period of their instruction. They are the following:

Un grande homme,	A great man.
Un homme grande,	A tall man.
Un petit homme,	A small man.
Un homme petit,	A mean man.
Un bon homme,	A simple-minded man.
Un homme bon,	A good man.
Un brave homme,	An honest man.
Un homme brave,	A brave man.
Une certaine chose,	A certain thing.
Une chose certaine,	A positive thing.
D'une commune voix,	Unanimously.
Une voix commune,	A common voice.
La dernière année de la guerre,	The last year of the war.
L'année dernière,	Last year.
Une sage femme,	A midwife.
Une femme sage,	A wise woman.
Un galant homme,	A man who has the character and manners of a gentleman.

Un homme galant,	A man who is gallant with the ladies.
Un gentil-homme,	A nobleman.
Un homme gentil,	A man who is pretty, gay, lively, &c.
De nouveau vin,	Some other kind of wine.
Du vin nouveau,	Wine newly made.
Un pauvre auteur,	A poor writer.
Un auteur pauvre,	A writer who is not rich.
Un honnête homme,	An honest man.
Un homme honnête,	A polite man.
Un malhonnête homme,	A dishonest man.
Un homme malhonnête,	A man of ill breeding.
Une méchante épigramme,	A flat epigram.
Une épigramme méchante,	A wicked epigram.

Of Adjectives which are placed after the Noun for the sake of Euphony.—Adjectives ending in *ic*, *ique*, *el*, *ile*, *ul*, *ule*, and *esque*, are those of the first termination always, and the others most generally, placed after the noun on account of euphony; as in, A public man, *Un homme public*; A public square, *Une place publique*; A splendid chateau, *Un château magnifique*; A trifle, *Une chose futile*; A credulous woman, *Une femme crédule*.

Of the place of Two or more Adjectives Qualifying the same Noun.—(1.) When two or several adjectives qualify a noun, and one of them belongs to the class of those which should always follow the noun, they are all placed after that which they qualify; as in, She is a beautiful, amiable, and accomplished woman, *C'est une femme belle, aimable, et accomplie*.

Accomplie, being derived from the past participle of the verb *to accomplish*, belongs to one of the classes mentioned above. An illustrious and classical author, *Un auteur illustre et classique*; because *classique* bears no necessary affinity to, nor is it necessarily in harmony with, the noun, inasmuch as it alludes rather to a class than to an individual.

(2.) But when both adjectives could individually be placed before the noun, it becomes a matter of taste and euphony, whether they precede or follow it; as in, A brave and intrepid soldier, *Un brave et intrépide soldat*, or, *Un soldat brave et intrépide*; A large and fine city, *Une grande et belle ville*, or, *Une ville grande et belle*.

There is a natural analogy between the idea of a soldier and that of bravery and intrepidity, and between the idea of a city and that of splendour and size.

(3.) When two adjectives are used to indicate the external appearance of persons and things, and one of them may on account of its meaning, be placed before the noun, that noun may be placed between the two; as in, I placed my goods in a large open basket, *Je plaçai mes marchandises dans un grand panier ouvert*; He is a tall, thin man, *C'est un grand homme maigre*.

Remark.—It should be observed, that adjective can never, as in English, be placed before a noun without being united by the conjunction *and* or *neither*, or, *et* or *ni*, *ou*; but they may follow it when there are more than two, and the conjunction *et* placed before the last; as in, Your sister is a pretty, amiable, rich, generous, and well-bred woman, *Votre sœur est une femme jolie, aimable, riche, généreuse, et bien née*.

Of Adjectives considered in reference to their relations with other words.—The relations of adjectives with other words are the following: 1st. Agreement of adjectives with nouns; 2nd. Use of adjectives with the article; 3rd. Object of the adjective.

Of the Agreement of Adjectives.—The adjective makes but *one* with the noun which it qualifies; consequently, it must follow the inflection of the noun and agree with it in number and gender; as, Good father, *Bon père*; Good mother, *Bonne mère*; Exquisite wine, *Excellents vins*; Handsome women, *Belles femmes*.

Of Adjectives qualifying several Nouns of the same Gender, and united by the Conjunction "And, Et."—Whenever an adjective is preceded or followed by several nouns of the same gender, and united by the conjunction *and*, *et*, it takes the plural, and is of the same gender as the nouns; as in, The Arabs have their face and body burnt by the heat of the sun, *Les Arabes ont le visage et le corps brûlés de l'ardeur du soleil*.

But if the nouns should have some similarity in their signification, as they would then in fact represent but one idea, the adjective should be used in the singular and agree with the last; as in, He received us with an insufferable ostentation and pride, *Il nous reçut avec un faste et un orgueil insupportable*.

Of Adjectives qualifying several Nouns of a different gender.—Whenever an adjective is used to qualify several nouns of a different gender, it is used in the plural number and masculine gender; as in, The inhabitants of the Strait of Davis eat their fish and meat raw, *Les habitants du détroit de Davis mangent leur poisson (m.) et leur viande (f.) crus*.

Euphony sometimes requires that the feminine noun should be expressed first when the adjective has not the same termination in either gender; thus we must say, The actor plays with perfect dignity and taste, *Cet acteur joue avec une noblesse et un goût parfaits*, rather than, *Cet acteur joue avec un goût et une noblesse parfaits*; because in this last sentence the feminine noun *noblesse* and the adjective *parfaits*, plural masculine, would form a dissonance disagreeable to the ear.

Of Adjectives qualifying several Nouns which are united by the Conjunction "And, Et."—When two or several nouns are synonymous in their meaning, and one only is intended to be qualified by the adjective which follows them both, this adjective agrees with the last. His whole life has been spent in continued labour and occupation, *Toute sa vie n'a été qu'un travail et une occupation continuelle*.

The same rule is applied whenever there is a gradation in the meaning of the several nouns qualified by the adjective; as in, The knife, the headband, the fire, all is ready, *Le fer, le bandeau, la flamme, est toute prête*.

Of Adjectives preceded by two or several Nouns, and relating only to the last.—When an adjective is preceded by several nouns, united or not by the conjunction *and*, *et*, and qualifies only the last, it should agree with this one and should not be used in the plural on account of those which precede it; as in, A smile is a sign of benevolence, approbation, and internal satisfaction, *Le sourire est une marque de bienveillance, d'applaudissement et de satisfaction intérieure*.

Of Adjectives preceded by several Nouns, separated by the Conjunction "Or, Ou."—When an adjective is preceded by two nouns separated by the conjunction *or*, *ou*, it agrees with the last if it is intended to qualify only one of them; as in, As Rome

was no longer free, and could no more be such, it mattered but little who would be its master, whether Pompeius or Cæsar, Rome n'étant plus libre et ne pouvant plus l'être, qu'importait que Pompée ou que César fût maître. *Maître* is in the singular, because there could be but one master in Rome.

But if the adjective should at once qualify the two nouns, the agreement should take place with both: as in, Who is the father who would not mourn over his son and daughter being lost for the world, Quel est le bon père de famille qui ne gémissé de voir son fils ou sa fille perdus pour la société.

Perdus is in the plural, because the mind refers to both as being lost.

Of Adjectives qualifying sometimes the first, sometimes the second Noun, when it is preceded by several Nouns separated by the Preposition "Of, De."—When an adjective is preceded by two nouns separated by *of*, *de*, it agrees with the first or the last, according to the sense of the sentence; as in, White silk stockings, Des bas de soie blancs; A skein of white silk, Un écheveau de soie blanche. In the first sentence, the mind does not think of the material which, being white, renders the stockings of that colour, but of the stockings themselves, which strike the eye as being white.

In the second example, it is the material which occupies the mind, the skein being only the shape in which it is presented to the eye.

Of Adjectives preceded by several Nouns separated by the Conjunctions "Ainsi Que, Aussi Bien Que," as well as, "Comme," as "Avec, With," &c.—When an adjective is used with several nouns separated by the above conjunctions or any other having the same signification, it agrees only with the first of those nouns if the sentence expresses a comparison, and with all, if the sentence implies the idea of addition or simultaneousness; as in, Truth as well as light is unalterable, La vérité comme la lumière est inaltérable (comparison); In Egypt, Asia, and Greece, Bacchus as well as Hercules was worshipped as a demi-god, Dans l'Egypte, dans l'Asie et dans la Grèce, Bacchus ainsi qu'Hercule étaient reconnus pour demi-Dieux (addition.)

Of Exceptions to the rules relating to the agreement of the Adjective.—*Of the Adjective "Feu," late.*—The adjective *feu*, *late*, is invariable when placed before the article or adjective possessive pronoun, but it varies if placed after them; as in, The late Queen, *Feu la reine* or *la feuë reine*; My late mother, *Feu ma mère* or *ma feuë mère*.

Of the Adjective "Nu," Naked.—The adjective *nu*, *naked*, remains invariable when it precedes a noun, but it agrees with that noun when it follows it; as in, He goes barefooted, Il va nu pieds or les pieds nus. But when the adjective *nu* is preceded by the article *the* used in the feminine, it agrees with the noun which it qualifies, although it is placed before it; as in, My father has kept for himself the title to his lands and given the revenue to his children, Mon père s'est conservé la nue propriété de ses terres et en a abandonné l'usufruit à ses enfants.

Of the Adjective "Demi," Half.—Whenever the adjective *demi* is placed before a noun, it forms with that noun a compound expression in which the two words are joined by a hyphen, and remains invariable; but when placed after the noun, it agrees with that noun in gender but not in number, for two halves make one whole; three halves make one whole and a half, &c.; thus we say: One hour and a half, Une heure et demie; Half an hour, Une demi-heure.

But if the word *demi* should be used as a noun in a sentence like the following, it should be used in the plural: This clock strikes the hours but not the half-hours, Cette horloge sonne les heures, mais elle ne sonne pas les demies.

Demi, although an adjective, is sometimes used as an adverb, and then it never varies; as in, Half-fool, half-dead, half-rotten, &c., *Demi-fou*, *demi-mort*, *demi-pourri*, &c.

Of the Adjectives Excepté, "Excepted," Passé, "Past," Supposé, "Supposed," Vu "Considering," Y Compris, "Here Included," Franc de Port, "Free of Postage," &c.—When the above expressions, or any of the same nature, are placed before a noun, they act as prepositions, and remain invariable; but they do vary when they follow it; as in, All is well made in this house except the doors, Tout est bien fait dans cette

maison *excepté les portes*; You will find here included a copy of my last letter, Vous trouverez *ci-inclus* une copie de ma dernière lettre; I recommend you the five letters here included, Je vous recommande les cinq lettres *ci-incluses*; You will receive this letter free of postage, Vous recevrez cette lettre *franche de port*; Vous recevrez *franc de port* la lettre *ci-jointe*.

Of Adjectives performing the parts of Adverbs or Nouns.—When an adjective is used to modify the signification of a verb, it acts the part of an adverb and does not vary; as in, This woman sings out of tune, Cette femme *chante faux*; This rose smells good, Cette rose *sent bon*.

If an adjective, used as such, acts the part of a noun, it never varies; as, The moulting of the agate canary-birds lasts longer than that of others, La mue des *serins agate* (de couleur agate) est plus longue que celle des autres.

When there are in a sentence two adjectives, the first of which is modified by the second, these two adjectives remain invariable; as, These tissues are of a dark blue, Ces étoffes sont (d'un) *bleu-foncé*; His hair is of a light chestnut colour, Il a les cheveux (d'un) *châtain-clair*.

But if the two adjectives, placed one after another, are both used to qualify the same noun, they must then agree with that noun; as, The hair of that child was chestnut, brown, and fine, Les cheveux de cet enfant étaient *châtains, bruns et fins*.

Of the Compound Adjectives "New-born, Dead-drunk," &c.—When in a compound adjective, the first is used adverbially, it remains invariable, and the second only changes; as in, New-born animals want their mother only for a few months, Les animaux *nouveau-nés* n'ont besoin, de leurs mères que pendant quelques mois.

Nouveau is used here instead of the adverb *nouvellement*, *newly*.

It should be observed that *nouveau* cannot be used adverbially before an adjective relating to a feminine noun; thus, we cannot say, Une fille *nouveau-neé*, but Une fille *nouvellement née*, for *A new-born girl*.

But if the first adjective is not used adverbially, and serves as well as the second to qualify the noun already expressed, they both vary; as in, Have you seen the newly-married couple? Avez-vous vu les *nouveaux-mariés*?

Of the Gender of Adjectives used with the word "Air, Appearance."—As it is sometimes difficult to ascertain the gender of the adjective which is used to qualify the word *air*, we will try to give some explanation on the subject.

Grammarians differ on this difficulty; we will therefore state here what we think to be consecrated by usage and the authority of good writers.

Avoir l'air, to have the appearance, to appear, may be used in speaking of animated beings or things.

(1.) When this expression is applied to animated beings, the adjective which is preceded by the word *air* expresses either a moral faculty, a quality, a metaphysical distinction, or else it designates a form, a manner of being merely physical.

In the first instance, as the adjective may always reasonably qualify the word *air*, it should agree with the noun; so we say, She looks frivolous and absent, Elle a l'*air léger et distrait*; They look haughty, but at the same time they are familiar, Elles ont l'*air hautain*, mais l'accueil *familier*; Do not have yourself painted in a riding-dress; you look too gentle for it, Ne vous faites pas peindre en Amazone; vous avez l'*air trop doux*; Parisian women do not appear awkward and embarrassed in their manners, Les Parisiennes n'ont pas l'*air gauche et embarrassé*.

In the second instance, as a physical quality cannot be applied to the word *air*, the adjective which follows that noun should agree with the animated being spoken of; as in, This lady seems to be well made, Cette dame a l'*air bien faite*; She looks pleased with what has just been said to her; Elle a l'*air contente* de ce qu'on vient de lui dire.

(2.) When *avoir l'air* is applied to things, there is no difficulty; for the adjective cannot qualify the noun *air*, as inanimate beings can only have physical qualifications; then we should say, This house looks as if it were strongly built, Cette maison a l'*air solidement bâtie*; This soup appears to be very good, Cette soupe a l'*air très bonne*.

In this latter case, the sentences are elliptical; the verb to be is understood. Some grammarians pretend that the ellipsis is not allowed in such cases; but usage has consecrated it, as well as many

of our best writers; and the sentence, *Cette soupe a l'air bonne*, is more generally used and more elegant than *Cette soupe a l'air d'être bonne*.

Of the agreement of Adjectives used in the Superlative Degree.—An adjective, when used in the superlative degree, has lost nothing of its nature of a qualificative, since it expresses still a quality in a very or in the highest degree; it therefore follows the general rule; but it is sometimes the case that a superlative refers to a noun which is not expressed; the sentence is then elliptical, and the mind supplying the noun understood, the adjective agrees with it; as in, *Winter is the dullest of seasons*, *L'hiver est (la saison) la plus triste des saisons*.

Remark.—Adjectives in the comparative or superlative degree in French, are most generally placed after the noun.

Of Adjectives as qualifying Nouns of Persons or Things only.—There are adjectives which can only qualify nouns of persons; such as, *économe*, saving; *inconsolable*, inconsolable; *patriote*, patriotic; *despote*, despotic, &c.; and others which can only be applied to things; as, *despotique*, despotic; *économique*, economical; *pardonnable*, excusable; *patriotique*, patriotic, &c. Adjectives which are derived from the verbs, such as, *pardonnable*, *inconsolable*, which come from *pardonner*, *consoler*, are applied to persons or things, inasmuch as these verbs have for their direct object a noun of person or thing; therefore, as we do not say in French, *Pardonner une personne*, we cannot use the expression, *Une personne pardonnable*; but as we say, *Pardonner une chose*, we can say, *Une chose pardonnable*. For the same reason, we cannot apply the adjective *inconsolable* to things, for persons and not things are to be consoled.

But although this rule is applicable in most cases, there are a few exceptions which usage renders legitimate as the following: *Un roi obéi*, a king who is obeyed; *Une chose convenue*, a thing agreed upon: *Un état désespéré*, a hopeless situation; although we cannot say, *Obéir un roi*, but *à un roi*; *Convenir une chose*, but *d'une chose*; *Désespérer une chose*, but *d'une chose*. There are other exceptions which the pupil will easily ascertain as he advances in a knowledge of French.

BOTANICAL GEOGRAPHY.

WHEN treating of the geographical distribution of vegetables, we have to mark the general arrangements indicated, and the agencies that have evidently operated in promoting the diffusion of floral tribes. Vegetation occurs over the whole globe, therefore, under the most opposite conditions. Plants flourish in the bosom of the ocean as well as on land, under the extremes of cold and heat in polar and equatorial regions, on the hardest rocks and the soft alluvium of the plains, amidst the perpetual snow of lofty mountains, and in springs at the temperature of boiling water, in situations never penetrated by the solar rays, as the dark vaults of caverns, and the walls of mines, as well as freely exposed to the influences of light and air. But these diverse circumstances have different species and genera. There is only one state which seems fatal to the existence of vegetable life—the entire absence of humidity.

By species we understand so many individuals as intimately resemble each other in appearance and properties, and agree in all their permanent characters, which are founded in the immutable laws of creation. An established species may frequently exhibit new varieties, depending upon local and accidental causes, but these are imperfectly, or for a limited time, if at all, perpetuated.

A genus comprises one or more species similar to each other, but essentially differing in formation, nature, and in many adventitious qualities from other plants. A tribe, family, group, or order, comprises several genera.

The known number of species in the vegetable kingdom has been gradually enlarged by the progress of maritime and inland discovery; but owing to great districts of the globe not having yet been explored by the botanist, the interior of Africa and Australia, with sections of America, Asia, and Oceanica, it is impossible to state the exact amount. The successive augmentation of the catalogue appears from the numbers below:

	Species.
Theophrastus	500
Pliny	1000

		Species.
Greek, Roman, and Arabian		
botanists		1,400
Bauhin		6,000
Linnæus		8,800
Persoon		27,000
Humboldt and Brown		38,000
De Candolle		56,000
Lindley		86,000
Hinds		89,000

Vegetable forms are divided into three great classes which differ materially in their structure:—1. Cryptogamous plants—those which have no flowers properly so called, mosses, lichens, fungi, and ferns; as distinguished from those which are phænogamous, or flower bearing, to which the two following classes belong. 2. Endogenous plants, which have stems increasing from within, also called Monocotyledons, from having only one seed-lobe, as the numerous grasses, lilies, and the palm family. 3. Exogenous plants, which have stems growing by additions from without, also called Dicotyledons, from the seed consisting of two lobes, the most perfect, beautiful, and numerous class, embracing the forest trees, most flowering shrubs and herbs.

The exogens furnish examples of gigantic size, and great longevity. In South America, on the banks of the Atabapo, Humboldt measured a *Bombax caiba* more than 120 feet high, and 15 in diameter; and near Cumana, he found the *Zamang del Guayra*, a species of mimosa, the pendant branches of the hemispherical head having a circumference of upwards of 600 feet. The *Adansonia*, or baobab of Senegal, though attaining no great height, rarely more than 50 feet, has a trunk with a diameter sometimes amounting to 34 feet; while the *Pinus Lambertiana*, growing singly on the plains west of the Rocky Mountains, has been found 250 feet high, 60 feet in circumference at the base, $4\frac{1}{2}$ feet in girth at the height of 190 feet, yielding cones 11 inches round and 16 long. The *Ficus Indicus*, or banian tree, sending out shoots from its horizontal branches, which reaching the ground take root, and form new stems, till a single tree multiplies almost to a forest, has been observed covering an area of 1700 square yards.

From the number of concentric zones

observed in a transverse section of the stems, De Candolle advances proof of the following ages:

Elm	335 years.
Cypress	about 350 "
Cheirostemon	400 "
Ivy	450 "
Larch	576 "
Orange	630 "
Olive	700 "
Oriental Plane, 720 years and upwards.	
Cedar of Lebanon, about 800	
Oak	810; 1080; 1500
Lime	1076; 1147
Yew	1214; 1458; 2588; 2880
Taxodium	4000 to 6000
Boabab	5150

Admitting, with Professor Henslow, that De Candolle overrated the ages of these trees one-third, they are examples of extraordinary longevity. Yew trees upwards of 700 years old remain at Fountains Abbey, Yorkshire, as there is historic evidence of their existence in the year 1133. But a yew in the churchyard of Darley-in-the-Dale, Derbyshire, is considered by Mr. Bowman as 2000 years old.

The cryptogamous plants afford the most numerous examples of wide diffusion. A lichen indigenous in Cornwall, *sticta aurata*, is also a native of the West India Islands, Brazil, St. Helena, and the Cape of Good Hope; while 38 lichens and 28 mosses are common to Great Britain and Australia, though the general vegetation of the two districts is remarkably discordant. Some species of endogenous plants are also widely distributed, the *Phleum alpinum* of Switzerland occurring without the slightest difference at the Strait of Magellan, and the quaking grasses of Europe in the interior of Southern Africa. But only in very few instances are the same species of exogenous plants met with in regions far apart from each other; and generally speaking, in passing from one country to another, we encounter a new flora; for if the same genera occur, the species are not identical, while in districts widely separated the genera are different.

The cryptogamic plants, mosses, lichens, ferns, and fungi, are to the whole mass of phænogamic vegetation, in the following proportions in different districts: Equatorial latitudes, 0° to 10° ; on the plains, $\frac{1}{25}$

on the mountains, $\frac{1}{3}$; mean latitudes, 45° to 52° , $\frac{1}{2}$; high latitudes, 67° to 70° , proportion about equal. Thus the proportion of flowerless vegetation to the flowering increases from the equator to the poles. But the family of ferns, *filices*, viewed singly, forms an exception to this law, decreasing as we depart from equinoctial countries, being $\frac{1}{20}$ in equatorial and $\frac{1}{70}$ in mean latitudes, and not found at all in the high latitudes of the new world.

In equinoctial and tropical countries, where a sufficient supply of moisture combines with the influence of light and heat, vegetation appears in all its magnitude and glory. Its lower orders, mosses, fungi, and conservæ, are very rare. The ferns are aborescent. Reeds ascend to the height of a hundred feet, and rigid grasses rise to forty. The forests are composed of majestic leafy evergreen trees bearing brilliant blossoms, their colours finely contrasting, scarcely any two standing together being of the same species. Enormous creepers climb their trunks; parasitical orchidæ hang in festoons from branch to branch, and augment the floral decoration with scarlet, purple, blue, rose, and golden dyes. Of plants used by man for food, or as luxuries, or for medicinal purposes, occurring in this region, rice, bananas, dates, cocoa, cacao, bread-fruit, coffee, tea, sugar, vanilla, Peruvian bark, pepper, cinnamon, cloves, and nutmegs, are either characteristic of it as principally cultivated within its limits, or entirely confined to them.

1. Rice (*Oryza-sativa*), the chief food of, perhaps, a third of the human race, is cultivated beyond the tropics, but principally within them, only where there is a plentiful supply of water. It has never been found wild; its native country is unknown; but probably southern Asia.

2. Bananas, or plantains (*Musa sapientum et paradisiaca*), are cultivated in inter-tropical Asia, Africa, and America. The latter species occurs in Syria. The banana is not known in an uncultivated state. Its produce is enormous, estimated to be on the same space of ground to that of wheat, as 133 to 1, and to that of potatoes as 44 to 1.

3. Dates (*Phoenix dactylifera*), and cocoa (*Cocos nucifera*), belong to the

family *Palmae*. The palms, remarkable for their elegant forms and importance to man, contribute more than any other trees to impress upon the vegetation of tropical and equinoctial countries its peculiar physiognomy. The date palm is a native of northern Africa, and is so abundant between the Barbary states and the Sahara, that the district has been named Biledulgerid, the land of dates. As the desert is approached, the only objects that break the monotony of the landscape are the date palm, and the tent of the Arab. It accompanies the margin of the mighty desert in all its sinuosities from the shores of the Atlantic to the confines of Persia, and is the only vegetable affording subsistence to man that can grow in such an arid situation. The annual produce of an individual is from 150 to 260lbs. weight of fruit. The cocoa palm furnishes annually about a hundred cocoa-nuts. It is spread throughout the torrid zone; but occurs most abundantly in the islands of the Indian archipelago. The family of palms is supposed to contain a thousand species, some of large size, forming extensive forests.

4. Cacao (*Theobroma cacao*), from the seeds of which chocolate is prepared, grows wild in central America, and is also extensively cultivated in Mexico, Guatemala, and on the coast of Cumana.

5. Bread-fruit tree (*Artocarpus incisa*), a native of the South Sea Islands and Indian archipelago, grows also in Southern Asia, and has been introduced into the tropical parts of America; but the fruit is not equal to the banana as an article of human food.

6. Coffee (*Coffea Arabica*.) The bush has probably for its native region the Ethiopian Highlands, from whence it was taken in the fifteenth century to the Highlands of Yemen, the southern part of the Arabian peninsula. It has been introduced, and is now extensively cultivated in British India, Ceylon, Java, the Mauritius, Brazil, and the West Indies, but the quality is inferior, which makes the climate of the Mocha coffee district of importance, as peculiarly favourable to the plant. It grows there on hills described by Niebuhr as being soaked with rain every day from the beginning of June to the end of September, which is care-

fully collected for the purpose of irrigation during the dry season. Forskhål gives the following temperatures in the district:

Beit el Fakih	March 16,	7 A.M. 76°	1 P.M. 95°	10 P.M. 81°
" " " " " "	" 18,	" 77	" 95	" 81
Hodeida.....	" 18,	" 72	" 92½	" 73
Bulgosa, a village in the hills.....	" 20,	" 69½	" 85½	" 73

Coffee was first introduced into Venice in 1615; into England in 1652; and into France in 1658.

7. Tea, (*Thea Chinensis*.) The plant is indigenous in China, Japan, and Upper Assam. In the latter country, it has recently been found in a wild state, and is in process there of extensive cultivation. As the plant is hardy, its culture has very lately been attempted in the south of France, and apparently with complete success. A similar experiment on the burning plains of Algeria completely failed, all the plants being killed by the heat, notwithstanding every precaution. Tea was first introduced into Europe by the Dutch in 1666. The leaves of the coffee-plant have long been used as a substitute for tea by the lower classes in Java and Sumatra; and recently, Professor Blume, of Leyden, exhibited samples of tea prepared from coffee-leaves, agreeing entirely in appearance, odour, and taste, with the genuine Chinese production.

8. Sugar-cane (*Saccharum officinarum*), a species of *Gramineæ*, occurs to some extent without the tropics, having been cultivated centuries ago in Europe, as at present scantily in the south of Spain. But it properly belongs to the torrid zone, and has for its principal districts, the Southern United States, the West Indies, Venezuela, Brazil, the Mauritius, British India, China, the Sunda and Philippine Islands. The plant was found wild in several parts of America on the discovery of that continent, and occurs in a wild state on many of the islands of the Pacific.

9. Vanilla (*Vanilla aromatica*), the fruit of which forms the well-known aromatic, grows principally in Mexico.

10. Peruvian bark (*Cinchona officinalis*), a forest tree, of which there are several species, furnishing the valuable medicine so called. It is exclusively confined to South America, and grows chiefly on the Andes of Loxa and Venezuela.

11. Pepper (*Piper nigrum*), belongs exclusively to the Malabar coast, where it has been found wild, Sumatra, which produces the greatest quantity, Borneo, the Malay peninsula, and Siam. Other species of *Piperaceæ* occur in tropical America.

12. Cinnamon (*Laurus Cinnamomum*), a small tree yielding the aromatic bark, is found native only in the island of Ceylon; but another species occurs in Cochin China.

13. Clove (*Myrtus caryophyllus*), an evergreen small tree, the dried flower-buds of which form the celebrated aromatic, grows naturally in the Moluccas, whence it has been conveyed to other tropical districts. The island of Amboyna, one of that group, is the principal seat of its cultivation. The lowest temperature there is 72°; the mean temperature of the year 82°.

14. Nutmeg (*Myristica moschata*), grows naturally in several islands of the eastern archipelago, but is principally cultivated in the Banda Isles.

Tropical families and forms successively vanish with an increase of distance from the equator, and new phases of vegetation mark the transition from hot to temperate climates. Vividly green meadows, abounding with tender herbs, replace the tall rigid grasses which form the impenetrable jungle; and instead of forests composed of towering evergreen trees, woods of the deciduous class appear, which cast their leaves in winter, and hybernate in the colder season, the oak, ash, elm, maple, beech, lime, alder, birch, and sycamore. The cultivation of the vine becomes characteristic, with the perfection of the cereal grasses, and a larger proportion of herbaceous annuals and cryptogamic plants.

The vine (*Vitis vinifera*) is less impatient of a cold winter than a cool summer. Hence its northern limit, which coincides with lat. 47° 30' on the west coast of France, rises in the interior, where, though the winters are colder, the summers are warmer, to lat. 49°, cuts the Rhine at Coblentz in lat. 50° 20', and ascends to 52° 31' in Germany.

Receding further from the equator, magnificent forests of the fir and pine tribe prevail, as in the central parts of Russia, on the southern shores of the Baltic, in Scandinavia, and North Ame-

rica. But some of the cereals are no longer cultivatable, and several timber-trees common to the temperate zone do not reach its northern limits. Gradually all ligneous vegetation disappears entirely as higher latitudes are approached, the woods having first dwindled to mere dwarfs in struggling with the elements, hostile to that state which nature destined them to assume. The limit of the forests is a sinuous line running along the extreme north of the old world; and extending from Hudson's Bay, lat. 60°, to the Mackenzie River, lat. 68°, and thence to Behring's Strait. The dwarf birch (*Betula nana*), a mere bush, is the last tree found on drawing near the eternal snow of the pole. At the island of Hammerfest, lat. 70° 40', near the North Cape, it rises to about the height of a man, in sheltered hollows between the mountains, its lower branches trailing on the ground, affording a shelter to the ptarmigan. In the polar zone, some low flowering annuals, saxifrages, ranunculi, gentians, chickweeds, and others, flourish during the brief ardent summer; a few perennials also accommodate themselves to the rigorous climate by spreading laterally, never rising higher than four or five inches from the ground; till finally no development of vegetable life is met with, but lichens, and the microscopic forms that colour the snow.

In Europe, wheat ceases with a line connecting Inverness in Scotland, lat 58°, Drontheim in Norway, lat. 64°, and Petersburg in Russia, lat. 60° 15'. Oats reach a somewhat higher latitude. Barley and rye ascend to lat. 70°, but require a favourable aspect and season to produce a crop.

The northern limit of the growth of oak, lat. 61°, falls short of that of wheat. The oak makes a singular leap at the confines of Europe and Asia, disappearing towards the Ural mountains. This is the case also with the wild-nut and apple. The oak and the wild-nut, however, re-appear suddenly in Eastern Asia, on the banks of the Argoun and the Amour; and the apple occurs anew in the Aleutian Isles.

The following are the northern limits of several trees in Scandinavia:

	Lat.
Beech, <i>Fagus silvatica</i>	60° 0'
Hard Oak, <i>Quercus robur</i>	61 0

	Lat.
Common Elm, <i>Ulmus campestris</i> .	61 0
Common Lime, <i>Tilia communis</i> .	61 0
Common Ash, <i>Fraxinus excelsior</i> .	62 0
Fruit trees	63 0
Hazel, <i>Corylus avellana</i>	64 0
Spruce Fir, <i>Abies excelsa</i>	67 40
Service Tree, <i>Sorbus aucuparia</i> .	70 0
Scotch Fir, <i>Pinus silvestris</i> . . .	70 0
White Birch, <i>Betula alba</i>	70 40
Dwarf Birch, <i>Betula nana</i>	71 0

Thus distinct vegetable regions are observed on passing from south to north through different climatic zones, defined as to their limits by the isothermal curves, and not by the parallels of latitude. Similar changes of vegetation mark a perpendicular transit through varying climates. A succession of plants appear on the tropical mountains which rise above the snow line, corresponding to those which are encountered in mean and high latitudes. The higher we ascend, the more does the number of the phænogamic class diminish in proportion to the cryptogamic, till only members of the latter family are found, whose further progress upward is arrested by the everlasting snow. The last lichen met with by Saussure on Mont Blanc, *Silene acaulis*, was also observed by M. Brevais in the neighbourhood of Bosekop, lat. 69° 58', where it was vegetating on the sea-shore, shaded by the last pines of Europe.

Isolated mountains display to the best advantage the effect of climatic change on vegetation.

1. Etna is divided into three great regions: *La Regione Culta*, or fertile region; *La Regione Sylvosa*, or woody region; *La Regione Deserta*, the bare or desert region. But each of these is susceptible of sub-divisions, defined by the presence of certain families of plants, forming seven botanical zones.

1. The sub-tropical zone, which does not rise more than 100 feet above the level of the sea, is characterised by the palm, banana, Indian fig, sugar-cane, varieties of mimosa and acacia, which with us are only found in conservatories.

2. The hilly zone rises about 2,000 feet, characterised by the orange, lemon, shaddock, maize, cotton, and grape plants.

*. The woody zone lies between the

height of 2,000 and 4,000 feet, where the cork-tree flourishes, several kinds of oak, the maple, and enormous chesnuts.

4. The zone between the height of 4,000 and 6,000 feet is distinguished by the beech, Scotch fir, birch, and, among small plants, by clover, sandwort, chickweed, dock, and plantain.

5. The sub-alpine zone, between the elevation of 6,000 and 7,500 feet, produces the barberry, soap-wort, toad-flax, and juniper.

6. The zone between 7,500 and 9,000 feet, has almost all the plants of the preceding, with the fleshy and jagged ground-sel.

7. The narrow zone between 9,000 and 9,200 feet, only produces a few lichens, beyond which there is complete sterility.

II. The Peak of Teneriffe exhibits five botanical districts, thus distinguished by Von Buch :

1. The region of Africa forms, 0—1,248 feet, comprising palms, bananas, the sugar-cane, various species of arborescent *Euphorbia*, *Mesembryanthema*, the *Dracæna*, and other plants, whose naked and tortuous trunks, succulent leaves, and bluish-green tints, are distinctive of the vegetation of Africa.

2. Region of Vines and Cereals, 1,248—2,748 feet, comprising also the olive, and the fruit-trees of Europe.

3. Region of Laurels, 2,748—4,350 feet, including lauri of four species, the wild olive, an oak, the iron-tree, the arbutus, and other evergreens. The ivy of the Canaries and various twining shrubs cover the trunks of the trees, and numerous species of fern occur, with beautiful flowering plants.

4. Region of the Pines, 4,350—6,270, characterised by a vast forest of trees resembling the Scotch fir, intermixed with juniper.

5. Region of the Retama, 6,270—11,061 feet, a species of broom, which forms oases in the midst of a desert of ashes, ornamented with fragrant flowers, and furnishing food to the goats which run wild on the Peak. A few gramineous and cryptogamic plants are observed higher, but the summit is entirely destitute of vegetation.

(To be continued.)

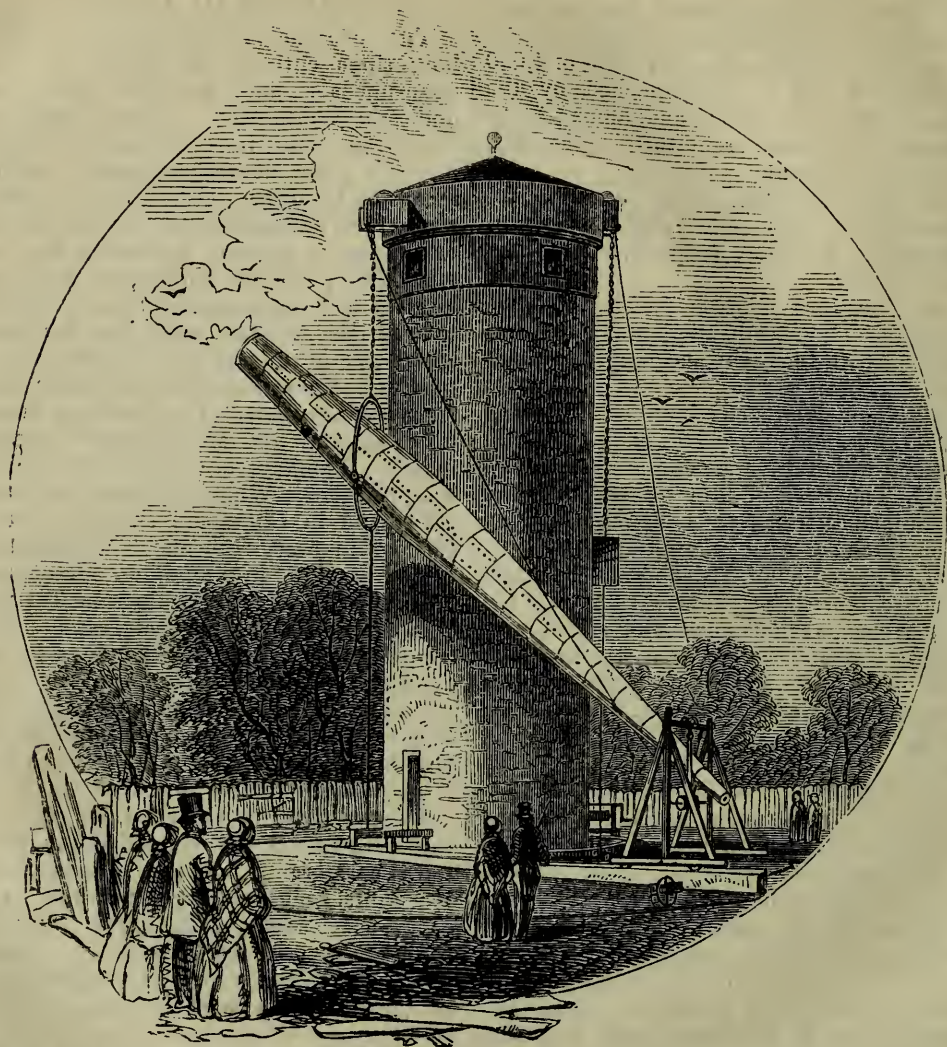
ANIMALS OF CHINA.

THE denseness of the population has long since entirely driven out all wild quadrupeds ; and there are also few domestic ones, such as are found in European countries. Beasts of burden are in a great degree superseded by the means of transport afforded by the numerous rivers and canals, and by the coolies or porters, a class of athletic men, who take the place of animals in carrying burdens and in dragging boats. Animals are excluded, to leave more food for men. There are no meadows for feeding cattle ; but the entire soil is used in raising food for the inhabitants. Wild cats are sometimes caught, and are considered a great dainty. Monkeys are found in the southern provinces. What few horses and asses are found in China are small, and very inferior in every respect. The buffalo is sometimes used in ploughing. Dromedaries are used between Peking and Tartary. There are also hogs, goats, and sheep. There is but one variety of dogs in the country, an animal about one foot high and two long, resembling a small spaniel. Rats are very abundant, and furnish the common people with meat. They are very large, and destructive to crops.

Of the *birds* in China, there are the eagle, the falcon, the magpie, crows, sparrows, cormorants, curlews, quails, larks, pheasants, pigeons, the rice-bird, and many species of aquatic birds. Cormorants are used by the Chinese for catching fish. The falcon is imperial property, and the magpie is sacred to the reigning family.

Fish form a very important part of the food of the Chinese, and great care is taken in raising them in artificial fish-ponds. The gold and silver fishes are kept in glass globes as ornaments. Among the fish eaten are the cod, sturgeon, mullet, carp, perch, sea-bream, &c. ; crab-fish and oysters are common on the coast.

The larger species of *reptiles* are unknown in China. Frogs, lizards, and fresh-water tortoises are common. Venomous serpents are very rare. The *insects* of China are numerous. The silkworm is the most important, affording employment and riches to thousands of the inhabitants.



THE CRAIG TELESCOPE

ON WANDSWORTH COMMON.

A stupendous telescope has been constructed on Wandsworth Common, under the general superintendence of Mr. Gravatt, for the Rev. Mr. Craig, Vicar of Leamington. It consists of a brick tower, 64 feet in height, and 15 feet in diameter, with a long tube slung at its side. The length of this tube, which is shaped somewhat like a cigar, is 76 feet; but with an eye-piece at the narrow end, and a dew-cap at the other, the total length in use

will be 85 feet. The design of the dew-cap is to prevent obscuration by the condensation of moisture which takes place during the night, when the instrument is most in use. Its exterior is of bright metal, the interior is painted black. The focal distance varies from 76 to 85 feet. The tube at its greatest circumference measures 13 feet, and this part is about 24 feet from the object-glass. The determination of this point was the result of repeated experiments, and minute and careful calculations. It was essential to the object in view, that there should not be

the slightest vibration in the instrument. Mr. Gravatt, reasoning from analogy, applied the principle of harmonic progression to the perfecting of an instrument for extending the range of vision, and thus aiding astronomic research. By his improvements, it is stated, the vibration at one end of the tube is neutralized by that at the other, and the utmost steadiness and precision are attained. The iron-work of the tube was manufactured by Messrs. Rennie, under the direction of Mr. Gravatt. The object-glass and all the optical works, were executed by Mr. Thomas Slater. Two glasses are used: one of flint, the other of plate glass. The plate-glass lens has a positive focal length of 30 feet $1\frac{1}{2}$ inches; its refractive index is 1.5103. The flint-glass lens has a negative focal length of 49 feet $10\frac{1}{2}$ inches; and the refractive index of this glass is 1.6308. These two lenses, placed in contact, are used in combination, and constitute the achromatic object-glass, the focal length of which is 76 feet, to parallel rays—that is, to all celestial objects, and it would be 85 feet focal length only to objects at about 700 feet distance from the object-glass. The tube rests upon a light wooden framework, with iron wheels attached, and is fitted to a circular iron railway, at a distance of 52 feet from the centre of the tower. The chain by which it is lowered is capable of sustaining a weight of 13 tons, though the weight of the tube is only 3. Notwithstanding the immense size of the instrument, the machinery is such that it can move either in azimuth, or up to an altitude of 80° , with as much ease and rapidity as an ordinary telescope, and, from the nature of the mechanical arrangements, with far greater certainty as to results. The slightest force applied to the wheel on the iron rail causes the instrument to move horizontally round the central tower, while a wheel at the right hand of the observer enables him to elevate or depress the object-glass with the greatest precision and facility. The largest eyepiece made for this instrument subtends to an angle of 30 minutes, its magnifying power is 125, and the diameter of the lenses 8 inches, which is about the size of the image of the full moon. The next size eyepiece is 4 inches diameter, subtends to an angle of

15 minutes, and magnifies 250. The range of eyepieces then vary from angles of 9 minutes to 50 seconds, and the magnifying powers from 500 to 3000. A popular notion of the extraordinary magnifying power of this instrument is conveyed by the statement, that by it a quarter inch letter can be read at the distance of half-a-mile.

THE MONTHS—JUNE.

“JUNE,” observes Dr. Aiken, in his delightful little work, “The Calendar of Nature,” “is really in this climate what the poets represent May to be—the most lovely month in the year. Summer is commenced, and warm weather thoroughly established; yet the heats rarely rise to excess, or interrupt the enjoyment of those pleasures which the scenes of Nature now afford. The trees are in their fullest dress, and a profusion of the gayest flowers is everywhere scattered around, which put on all their beauty just before they are cut down by the scythe, or withered by heat.”

Many years ago we made several botanical excursions, during the flowery month of June, in the neighbourhood of London, and since then have examined the floral beauties of various parts of our own country, and the shores of other lands. At present we are quietly enjoying the beauties of the West of England, seated in our old arm-chair, and gazing, from the latticed window of our peaceful abode, upon the fair landscape before us. 'Tis beautiful, indeed, and a rich treat after the noise, the smoke, and confusion of London.

“Away it sweeps

A wide, a smiling prospect, gay with flowers,
And waving grass, and trees of amplest growth,
And sparkling rills, and rivers winding slow
Through all the smooth immense. Upon the
eye

Arise the village and the village spire,
The clustering hamlet, and the peaceful cot
Clasp'd by the woodbine.*”

Let us hasten into the shady lanes of blooming hawthorn (*Cratægus oxyacantha*), the emblem of hope, and which is so late this year in putting forth its flowers. I will repay us for the trouble of dressing, to look upon its pretty blossoms tinged

* *Lonicera Periclymenum et Caprifolium.*

with pink, and laden with rich perfume, for, as Shakspeare remarks,

“Gives not the hawthorn-bush a sweeter shade,
To shepherds, looking on their silly sheep,
Than doth a rich embroidered canopy
To kings, that fear their subjects’ treachery?
O! yes, it doth; a thousand-fold it doth.

Let us seat ourselves beneath yon

“Monarch oak, the sturdy growth of ages;”

and listen to the incessant hum of the busy bee, drinking sweets from the various flowers around, while we ourselves collect instruction from the same source.

Yonder rock is a favourite spot of mine, when the duties of the day have terminated; seated there, upon its time-worn surface, I enjoy the prospect; for while the silvery stream bubbles at my feet,

“And the lime, at dewy eve
Diffusing odours,”

waves its branches on high, the glow-worm’s (*Lampyrus noctiluca*) light steals through the grass and illumines the sequestered nook, when the purple twilight has crept upon us almost imperceptibly. It is a sweet spot to sit and muse at summer’s noon, when the sun’s bright beams stream through the quivering leaves, and fall on the mazy streamlet at my feet, where the finny throng sport the day throughout,

“And each inconstant breeze that blows
Steals essence from the musky rose.”*

Here is a well-stocked bed of summer flowers for us to study. Observe how nicely they are arranged, how neatly they are tied up, trimmed, and trained. There is a beautiful group of petunias, the white flowers contrasting with the blue ones. The white variety (*Petunia nyctaginiflora*) comes from Brazil, and although now very common in our gardens, is nevertheless a favourite on account of its fragrance. The common blue kind (*P. violacea*) was originally brought from Buenos Ayres, about the year 1830, and since then we have had petunias varying in colour and size, the result of careful cultivation. Our attention is called towards that group of flowers with pea-shaped blossoms, and digitate leaves; they are lupines, so called from *lupus*, a wolf, because they are sup-

posed to destroy the fertility of the soil. You see that some of them have white flowers (*Lupinus albus*); they are natives of the Levant, and are cultivated in the south of Europe, and some parts of Italy, on poor, dry ground, which is too bad for other plants; they are ploughed in to improve the land. There are some of the Egyptian white lupines (*L. termis*) among the group; and the variable kind (*L. varius*) which will flower next month; then you see the hairy lupine (*L. hirsutus*); the yellow lupine (*L. luteus*); the silky lupine (*L. sericeus*); the silvery lupine (*L. argenteus*); the shrub lupine (*L. arbustus*), and the tomentose lupine (*L. tomentosus*) from Peru. Mingling with the other flowers you may observe

“The London tufts of many a mottled hue;*
The pale pink pea,† and monkshood‡ darkly blue;
The white and purple gilly flowers,§ that stay
Lingering in blossom summer half away;
The single blood walls,|| of a luscious smell,
Old fashioned flowers which housewives love
so well;
The columbines,¶ stone blue, or deep night brown,
Their honey-comb like blossoms hanging down;
Each cottage garden’s fond adopted child,
Though heaths still claim them, where they
yet grow wild;
With majoram knots,** sweet briar,†† and
ribbon grass,‡‡
And lavender, §§ the choice of every lass.”

Do not the various kinds of nasturtium, or Indian cress, look pretty as they climb over the trellis-work of yonder cottage door? There is the common kind (*Tropæolum majus*), so familiar to us all, the leaves of which improve a salad, while the young seeds are often pickled as a substitute for capers. The dark red-brown variety (*T. major atrosanguineum*) forms a strong and pleasing contrast to the former species, and the fairy-like canary bird creeping nasturtium (*T. peregrinum*) with its golden-coloured flowers.

The beautiful blossoms of the passion flower (*Passiflora cærulea*) are enticing us to notice them, as they peep from their dark green digitate leaves which shadow the window of the rustic cot. In former

* *Saxifraga umbrosa*. † *Lathyrus odoratus*.

‡ *Aconitum napellus*. § *Mathiola incana*.

¶ *Cheiranthus cheiri*. || *Aquilegia vulgaris*.

** *Rosa rubiginosa*. †† *Plantago lanceolata*.

‡‡ *Origanum majorana*. §§ *Laxandula spica*.

times the monks regarded the various parts as symbolical of the crucifixion of our Lord; thus, the five anthers represented the five wounds on the body of our Saviour; the triple style, the three nails by which he was nailed to the cross; the central column, the pillar to which he was bound; while the rays of the flower were considered to be either the crown of thorns or the glory surrounding our Saviour's head. How beautifully the large and peculiar flowers of the passion-flower contrast with the elegant drooping blossoms of the scarlet fuchsia (*Fuchsia eoccinea*) at its root; the splendid fuchsia (*F. fulgens*); the globe fuchsia (*F. globosa*); and the slender fuchsia (*F. gracilis*).

No doubt you notice

"The jasmine,* throwing wide her elegant sweets,
The deep dark green of whose unvarnished leaf
Makes more conspicuous, and illumines more
The bright profusion of her scatter'd stars;"

It is symbolical of amiability, and is much prized for its fragrance.

Look at yon rose bed, with its many beautiful specimens, among which is the damask-rose (*Rosa Damascena*), a native of Damascus; the French rose (*R. Gallica*); the cabbage or Provence rose (*R. centifolia*); and the dark Bourbon rose (*R. Bourboniana*), forming a strong contrast to the delicate pale petals of the China or monthly rose (*R. Indica*), and the Provence rose (*R. Provençialis*).

In this bed and the adjoining border, you observe we have a great variety of garden flowers and shrubs. In the shady part you may see the common foxglove (*Digitalis purpurea*); the iron foxglove (*D. ferruginea*); the yellow foxglove (*D. ambigua*), which comes from Switzerland, and the Madeira variety (*D. sceptrum*), which towers above them all with its large yellow bells. Near to us, we see the Greek valerian (*Potemonium cœruleum*); the garden poppy (*Papaver somniferum*); yellow poppy (*P. nudicaule*); the scarlet poppy (*P. Orientale*); and the yellow Mexican poppy (*Argemone Mexicana*).

In the hedges the place of the hawthorn is supplied by the flowers of the hip, or

dog-rose, the different hues of which, from a deep crimson to a light blush, and even pure white, form a very elegant variety of colour; and of some the smell is peculiarly fragrant. Some time after, the woodbine and honeysuckle begin to blow; and these, united with the rose, give our hedges their highest beauty and fragrance.

The several kinds of corn come into ear and flower this month; as do likewise the numerous species of grass. In Europe the principal kinds of corn are wheat, rye, barley, and oats; in Asia rice; in Africa maize, or Indian corn.

The latter part of June is the beginning of hay-harvest for the southern and middle parts of the kingdom. This is one of the most busy and agreeable of rural occupations.

"Now swarms the villager o'er the jovial mead."
Both sexes and all ages are engaged in it.

The fragrance of the new-mown hay, the gaiety of all surrounding objects, and the genial warmth of the weather, conspire to render this a season of pleasure and delight.

"E'en stooping age is here; and infant hands
Trail the long rake, or, with the fragrant load
O'ercharg'd, amid the kind oppression roll;
While, heard from dale to dale,
Waking the breeze, resounds the blended voice
Of happy labour, love, and social glee."

In this month appear the grasshopper, green beetle, angler's May-fly, the formidable gad-fly, &c. The angler's May-fly is most short-lived; emerging from the water in its *aurelia* state at six in the evening, and dying at eleven: they appear about the 4th of this month, and continue a fortnight.

Now gooseberries, currants, and strawberries, begin to ripen. Birds cease their notes, except the stone-curlew, yellow-hammer, gold-finch, and golden-crested wren, now and then chirping. The cuckoo also ceases. It is amusing now, an hour before sun-set, to see the barn owl in search of field mice, and bringing one to its nest about every five minutes; and the fern owl, feeding on the fern chaffer, another interesting nocturnal bird.

On the 21st of this month is the summer solstice, or longest day; when the splendid sun

"Shoots full perfection thro' the swelling year."

* The yellow (*Jasminum humile*); the white (*J. officinale*).

DISTRIBUTION OF ANIMALS.

A comparison between the quadrupeds of the Old and New Worlds is in every point strikingly in favour of the former. Not only has the western continent no animals of such giant bulk as those of the eastern, but no examples of such high organisation, such power and courage, as the African lion and the Asiatic tiger display. Buffon's remark must indeed be considerably modified, respecting the cowardice of the American feline race; for the jaguar of the woods about the Amazon, when attacked by man, will not hesitate to accept his challenge, will even become the assailant, nor shrink from an encounter against the greatest odds. The following passages from the writings of Humboldt show that this Transatlantic animal is not to be despised:—"The night was gloomy; the Devil's Wall and its denticulated rocks appeared from time to time at a distance, illuminated by the burning of the savannahs, or wrapped in ruddy smoke. At the spot where the bushes were the thickest, our horses were frightened by the yell of an animal that seemed to follow us closely. It was a large jaguar, that had roamed for three years among these mountains. He had constantly escaped the pursuit of the boldest hunters, and had carried off horses and mules from the midst of enclosures; but, having no want of food, had *not yet* attacked men. The negro who conducted us uttered wild cries. He thought he should frighten the jaguar; but these means were of course without effect. The jaguar, like the wolf of Europe, follows travellers even when he will not attack them; the wolf in the open fields and in unsheltered places, the jaguar skirting the road, and appearing only at intervals between the bushes." The same illustrious observer also remarks,—“Near the Joval, nature assumes an awful and savage aspect. We there saw the largest jaguar we had ever met with. The natives themselves were astonished at its prodigious length, which surpassed that of all the tigers of India I had seen in the collections of Europe.” Still, these were extraordinary specimens of the race, and leave the fact undoubted, that the most formidable of the western *Feræ* has no preten-

sions to an equality with his congener, the tyrant of the jungles of Bengal.

In vain also we look among the tribes of America for a rival in outward appearance to the giraffe, so remarkable for its height, its swan-like neck, gentle habits, and soft expressive eye; while of the animals most serviceable to mankind—the horse, the ox, the ass, the goat, and the hog,—not a living example of either was known there before its occupancy by the Europeans. But however inferior the animal races of the New may be as compared to those of the Old World, the balance between the two appears to have been pretty equal in remote ages: geological discovery has disproved the assertion of Buffon, that the creative force in America in relation to quadrupeds never possessed great vigour, and has established the fact, that it is only the more recent specimens of its energy that are upon an inferior scale. The relics of the unwieldy megatherium, of the gigantic sloth, and armadillo-like animals, discovered in great abundance imbedded in its soil, prove that at a former period it swarmed with monsters of equal bulk with those that now roam in the midst of Africa and Asia. The estuary deposit that forms the plains westward of Buenos Ayres, and covers the gigantic rocks of the Banda Oriental, appears to be the grave of extinct gigantic quadrupeds.

There are various animals which are very widely dispersed, enduring the extremes of tropical heat and of polar cold, which are either in a wild condition or in a state of domestication. Wild races, considered to be varieties of the domestic dog, occur in India, Sumatra, Australia, Beloochistan, Natolia, Nubia, various parts of Africa, and both the Americas; while in subjection to man, the dog is his faithful companion, and has followed his steps into every diversity of climate and of situation to which he has wandered. The north temperate zone of the Old Continent appears to be the native region of the ox, which passes in Lapland within the arctic circle, and has been spread over South America since its first introduction by the Spaniards. The horse, originally an inhabitant of the temperate parts of the Old World, has shared in a similar dispersion, and now exists in the

high latitude of Iceland, in the desolate regions of Patagonia, and roams wild in immense herds over the Llanos of the Orinoco, leading a painful and restless life in the burning climate of the tropics. Humboldt draws a striking picture of the sufferings of these gifts of the Old World to the New, returned to a savage state in their western location:—"In the rainy season, the horses that wander in the savannah, and have not time to reach the rising grounds of the Llanos, perish by hundreds amidst the overflowings of the rivers. The mares are seen, followed by their colts, swimming, during a part of the day, to feed upon the grass, the tops of which alone wave above the waters. In this state they are pursued by the crocodiles; and it is by no means uncommon to find the prints of the teeth of these carnivorous reptiles on their thighs. Pressed alternately by excess of drought and of humidity, they sometimes seek a pool, in the midst of a bare and dusty soil, to quench their thirst; and at other times flee from water and the overflowing rivers, as menaced by an enemy that encounters them in every direction. Harassed during the day by gad-flies and mosquitoes, the horses, mules, and cows find themselves attacked at night by enormous bats, that fasten on their backs, and cause wounds which become dangerous, because they are filled with acaridæ and other hurtful insects. In the time of great drought, the mules gnaw even the thorny melocactus (melon-thistle), in order to drink its cooling juice, and draw it forth as from a vegetable fountain. During the great inundations, these same animals lead an amphibious life, surrounded by crocodiles, water-serpents, and manatees. Yet, such are the immutable laws of nature, their races are preserved in the struggle with the elements, and amid so many sufferings and dangers. When the waters retire, and the rivers return into their beds, the savannah is spread over with a fine odoriferous grass; and the animals of old Europe and Upper Asia seem to enjoy, as in their native climate, the renewed vegetation of spring." The first colonists of La Plata landed with seventy-two horses, in the year 1535, when, owing to a temporary desertion of the colony, the animals ran wild;

and in 1580, only forty-five years afterwards, it had reached the Straits of Magellan. The ass has a more restricted range than the horse, not being capable of enduring so great a degree of cold, though usually far from being considered a delicate animal. To the warmer parts of the temperate zone, between the 20th and the 40th parallels of latitude, the ass seems best adapted, not propagating much beyond the 60th, and only occurring in a state of degeneration beyond the 52nd. The sheep and goat tribe are widely spread, equally supporting the extremes of temperature. According to Zimmerman, the *Argali* or *Mouflon*, the original race of sheep, still exists on all the great mountains of the two continents; and the *Capricorn* and *Ibex*, the ancestors of the common goat, inhabit the high European elevations. From the 64th degree of north latitude, the hog is met with all over the old continent, and also in the islands of the Indian Ocean, peopled by the Malay race; and since its introduction into the New World, it has diffused itself over it, from the 50th parallel north as far as Patagonia. Originally the cat was not known in America, nor in any part of Oceanica; but it has now spread into almost every country of the globe. Among animals entirely wild, the most extensively diffused are, the fox, hare, squirrel, and ermine; but the species are different in every region of the world; nor is there perhaps one example to be found of a species perfectly identical naturally existing in distant localities of the earth.

ROTATION OF CROPS.—It has been found from experience, that a repetition of the same crops in succession has a peculiar effect on the soil, so that if grain of the same nature be sown year after year in the same ground, it will not produce the same return of the seed, even when abundantly manured. The reason of this has not yet been satisfactorily explained. It has been observed, however, that it is the formation of the seed which principally causes the deterioration of the soil: for, if the crop be fed off in a green state, or mown before the seed is formed, the same may be safely repeated, and no diminution of the plants is apparent.

THE AURORA BOREALIS AND THE ELECTRIC TELEGRAPH.

ON some telegraphs the effect produced by the aurora is generally to increase or diminish the electric current used in working the wires; sometimes it neutralizes it, so that, in effect, no fluid is discoverable on them. The Bain, or Chemical Telegraph is, however, much the best adapted for observing the precise effect produced by the aurora. In this system, the main, or line wire, is brought into direct contact with the chemically prepared paper, which lies on a metal disc, connected with the ground; any action of the atmospheric current is therefore immediately recorded on paper.

During a thunderstorm, the atmospheric electricity attracted by the wires passes over them to the ground, and as it passes from the wire to the paper it emits a bright spark, and produces a sound like the snapping of a pistol. Atmospheric electricity never remains for any length of time on the wires; it will, however, sometimes travel many miles before discharging itself, sometimes as much as forty or fifty miles. The effect produced by the aurora borealis on the wires, and the record on paper, is entirely different from that of the atmospheric current. Instead of discharging itself from the wires with a flash and report, and without the aid of a conductor, as is the case with the latter, it glides along the wires in a continuous stream, producing the same result on paper as that produced by the galvanic battery. It is well known that only the positive pole of the battery produces the coloured mark on the paper,—the negative having the contrary effect of bleaching it; the same is also true of the two currents from the aurora. The current usually commences lightly, producing a blue line just perceptible on the paper, and gradually increasing in strength, making a dark blue, and then a black line, till finally it becomes so strong as to burn through several thicknesses of it, until it gradually disappears, and is followed by the bleaching process, which entirely neutralizes the current from the batteries.

The aurora borealis seems to be composed of a vast mass of electric matter, resembling in every respect that gene-

rated by the electro-galvanic battery; the currents from it change, coming on the wires and then disappearing—as the mass of the aurora rolls from the horizon to the zenith—sometimes so faintly as to be scarcely perceptible, and then so strongly as to emit one continuous blaze of fire—yet very different from what is termed atmospheric electricity, placing ground wire conductors in close proximity to the line wires being of no avail in this instance.—*Scientific American.*

ZAMANG TREE.

“ON leaving the village of Turmero,” says Humboldt, “we discover, at the distance of a league, an object which appears on the horizon like a round hillock, or a tumulus covered with vegetation. It is not a hill, however, nor a group of very close trees, but a single tree, the celebrated *Zamang of Guayra*, known over the whole province for the enormous extent of its branches, which form a hemispherical top, 614 feet in circumference. The zamang is a beautiful species of mimosa, whose tortuous branches divide by forking. Its slim and delicate foliage is agreeably detached on the blue of the sky. We rested a long while beneath this vegetable arch. The trunk of the Guayra zamang, which grows on the road from Turmero to Maracay, is not more than 64 feet high and 9½ feet in diameter; but its real beauty consists in the general form of its top. The branches stretch out like the spokes of a great umbrella, and all incline towards the ground, from which they uniformly remain twelve or fifteen feet distant. The circumference of the branches or foliage is so regular, that I found the different diameters 205 and 198 feet. One side of the tree was entirely stripped of leaves from the effect of drought, while on the other both foliage and flowers remained. The branches were covered with creeping plants. The inhabitants of these valleys, and especially the Indians, have a great veneration for the Guayra zamang, which the first conquerors seem to have found nearly in the same state as that in which we now see it. Since it has been attentively observed, no change has been noticed in its size or form. It must be at least as old as the dragon-tree of Orotava.”

NATURAL PHILOSOPHY.

OF UNDULATIONS.—CONTINUED.

IN ærial waves, precisely as in the surface waves of water, interference arises under the proper conditions. Thus, let $a m p h$, Fig. 197, be a wave advancing toward c , and

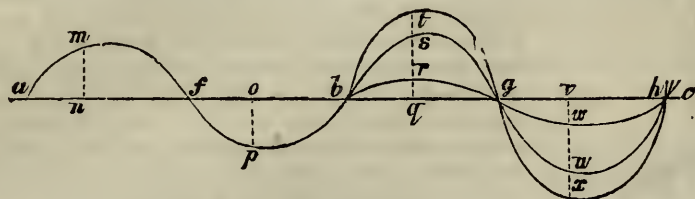


Fig. 197.

$m n, o p$ be the intensity of its vibration, or the maximum distances of the excursions of its vibrating particles. Then suppose a second wave, originating at b (a distance from a precisely equal to one wave length), the intensity of vibration of which is represented by $q r$. The motions of this second wave coinciding throughout its length with the motions of the first, the force of both systems is increased. The intensity, therefore, of the wave, arising from their conjoint action at any point, q will be equal to the sum of their intensities, $q r, q s$ —that is, it will be $q t$, and for any other point, v , it will be equal to the sum of $v w$ and $v u$ —that is, $v x$. So the new wave will be represented by $b t g x h$.

Now let things remain as before, except that the point of impact of the second wave, instead of being one whole wave from a , is only half a wave, the effects on any particle, such as q , take place in opposite directions, the second wave moving it with the intensity and direction $q r$, the first with $q s$ —the resultant of its movement in intensity and direction, will, therefore, be the difference of these quantities—that is, $q t$. And the same reasoning continued gives, for the wave resulting from this conjoint action, $b t g x h c$.

Under the circumstances given in Fig. 198, the systems of waves increase each other's

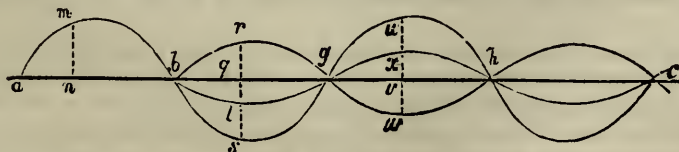


Fig. 198.

force; under those of Fig 197, they diminish it; or if equal to one another counteract completely, and total interference results.

Waves in the air, as they expand, have their superficies continually increasing, as the squares of their radii of distance from the original point of disturbance. Hence the effect of all such waves is to diminish as the squares of the distances increase.

THE LAWS OF SOUND.—ACOUSTICS.

CHAPTER XXXII.

PRODUCTION OF SOUND.

The Note Depends on Frequency of Vibration.—Distinguishing Powers of the Ear.—Soniferous Media.—Origin of Sounds in the Air.—Elasticity Required and Given in the Case of Strings by Stretching.—Rate of Velocity of Sounds.—All Sounds Transmitted with Equal Speed.—Distances Determined by it.—High and Low Sounds.—Three Directions of Vibration.—Intensity of Sound.—Quality of Sounds.—The Diatonic Scale.

WHEN a thin elastic plate is made to vibrate, one of its ends being held firm in a vice, and the other being free, as in Fig. 199, and its length limited to a few inches, it emits a clear musical note. If it be gradually lengthened, it yields notes of different characters, and finally all sound ceases, the vibrations becoming so slow that the eye can follow them without difficulty.

This instructive experiment gives us a clear insight into the nature of musical sounds, and, indeed, of all sounds generally. A substance which is executing a vibratory movement, provided the vibrations follow one another with sufficient rapidity, yields a musical sound; but when those vibrations fall below a certain rate, the ear can no longer distinguish the effect of their impulsions.

The number of vibrations which such a plate makes in a given time depends upon its length, being inversely as the square of the length of the vibrating part. Thus, if we take a given plate and reduce its length, the vibrations will increase in rapidity; when it is half as long it vibrates four times as fast; when one fourth, sixteen times, &c.

All sounds arise in vibratory movements, and musical notes differ from one another in the rapidity of their vibrations—the more rapidly recurring or frequent the vibration the higher the note.

There is, therefore, no difficulty in determining how many vibrations are required to produce any given note. We have merely to find the length of a plate which will yield the note in question, knowing previously what length of it is required to make a determinate number of vibrations in a given space of time. Thus it has been found that the ear can distinguish a sound made by 15 vibrations in a second, and can still continue to hear though the number reaches 48,000 per second.

That all sounds arise in these pulsatory movements common observations abundantly prove. If we touch a bell, or the string of a piano, or the prong of a tuning-fork, we feel at once the vibratory action, and with the cessation of that motion the sound dies away.

But the pulsations of such a body are not alone sufficient to produce the phenomena of sound. Media must intervene between them and the organ of hearing. In most cases the medium is atmospheric air, and when this is taken away the effect of the vibrations wholly ceases. Thus, a bell, or a musical snuff-box, under an exhausted receiver, as we have already seen (Chapter VII., Fig. 38), can no longer be heard; but on re-admitting the air the sound becomes audible. The sounding body, therefore, requires a soniferous medium to propagate its impulses to the ear.

Atmospheric air is far from being the only soniferous medium. Sounds pass with facility through water; the scratching of a pin or the ticking of a watch may be heard by the ear applied at the end of a very long plank of wood. Any uniform elastic medium is capable of transmitting sound; but bodies which are imperfectly elastic, or have not an uniform density, impair its passage to a corresponding degree.

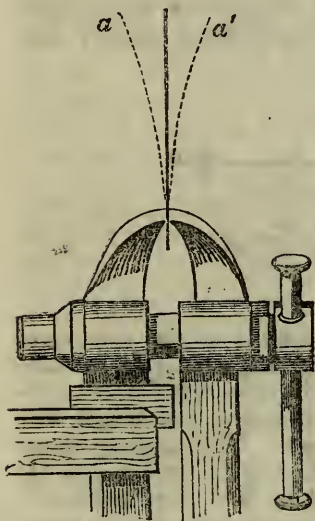


Fig. 199.

The effect of a vibrating spring, or, indeed, of any vibrating body on the atmospheric air, is to establish in it a series of condensations and rarefactions which give rise to waves. These, extending spherically from the point of disturbance, advance forward until they impinge on the ear, the structure of which is so arranged that the movement is impressed on the auditory nerves, and gives rise to the sensation which we term sound.

Both the sonorous body and the soniferous medium, must, therefore, be elastic; the regularity of the pulsations of the former depends upon the uniformity of its elasticity. In the case of strings, we give them the requisite degree of elastic force by stretching them to the proper degree. And, as the undulatory movements which arise in the soniferous medium are not instantaneous, but successive, it follows that the transmission of sound in any medium requires time. That this is the case, we may satisfy ourselves by remarking the period that elapses between seeing the flash of a gun and hearing the report. It is greater as we are removed to a greater distance. In different media, the velocity of transmission depends on the density and specific elasticity. It has been found, by experiment that in tranquil air the velocity of sound at 60° , and at an average state of moisture, is 1,120 feet in a second. The wind accelerates or retards sound, according to its direction, damp air transmits it more slowly than dry, and hot air more rapidly than cold, the velocity increasing about 1.1 foot for every Fahrenheit degree.

In a soniferous medium, all sounds move equally fast; it is wholly immaterial what may be their quality, or their intensity. Thus, we know that even the most intricate music executed at a distance is heard without any discord, and precisely as it would be close at hand. Nor does it matter whether it be by the human voice, a flute, a bugle, or, indeed, by many different instruments at once; the relation of the difference of sounds is accurately preserved. But this can only take place as a consequence of the equal velocity of transmission; for if some of these sounds moved faster than others discord must inevitably ensue.

The experiments of Colladon and Sturm on the Lake of Geneva show that the velocity in water is about four times that in air, being 4,708 feet in a second. With respect to solid substances, it is stated that the velocity in air being 1, that in tin is $7\frac{1}{2}$, in copper 12, in glass 17.

Advantage is sometimes taken of these principles to determine distances. If we observe the time elapsing between the flash of a gun and hearing the sound, or between seeing lightning and hearing the thunder, every second answers to 1,120 feet.

Sounds are of different kinds: some are low or high, grave or acute, according as the vibrations are slower or faster. Again: the intensity of vibration or the magnitudes of the excursions which the vibrating particles make, determine the force of sounds, an intense vibration giving a loud, and a less vibration a feeble sound.

The vibrations of a soniferous body may take place in three directions: they may be longitudinal, transverse, or rotatory vibrations; or, indeed, they may all co-exist. A

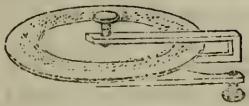


Fig. 200.

body may be divided into vibrating parts, separated from one another by nodal points or lines. Thus, if we take a glass or metal plate, and having strewed its surface with fine dry sand, and holding it firmly at one point between the thumb and finger, or in a clamp, as represented in Fig. 200, draw a violin bow across its edge, it yields a musical note, and the sand is thrown off those places which are in motion, and collects on the nodal points, which are at rest.

The *quantity*, or *strength*, or *intensity* of a sound depends on the intensity of the vibrations and the mass of the sounding body. It also varies with the distance, being inversely proportional to its square.

Musical sounds are spoken of as notes, or as *high* and *low*. Of two notes, the higher is that which arises from more rapid, and the lower from slower vibrations.

Besides this, sounds differ in their quality. The same note emitted by a flute, a violin, a piano, or the human voice, is wholly different, and in each instance peculiar. In what this peculiarity consists we are not able to say.

The several notes are distinguished by letters and names; we shall also see presently that they may be distinguished by numbers. They are—

C D E F G A B C.

Or, ut, re, mi, fa, sol, la, si, ut.

Such a series of sounds passes under the name of the diatonic scale.

CHAPTER XXXIII.

PHENOMENA OF SOUND.

Notes in unison.—Concords and Discords.—Octave.—Interval of Sounds.—Melody.—Harmony.—The Monochord.—Length of Cord and Number of Vibrations required for each Note.—Laws of Vibrations in Cords, Rods, Planes.—Acoustic Figures on Plates.—Vibration of Columns of Air.—Interference of Sounds.—Whispering Galleries.—Echoes.—Speaking and Hearing-Trumpet.

Two notes are said to be in *unison* when the vibrations which cause them are performed in equal times. If the one makes twice as many vibrations as the other, it is said to be its *octave*, and the *relation* or *interval* there is between two sounds is the proportion between their respective numbers of vibrations.

["When two strings are vibrating together in different times, or not in unison, the ear can distinctly perceive the note of both; but besides these two separate notes, there will be an impression from the two jointly, very different from that which it receives from either of them separately, and which leads to some curious considerations. This impression is sometimes most agreeable, at others harsh and grating, and according to these sensations the sounds are said to be in concordance or discordance. But the remarkable fact is, that this impression of concord will be experienced whenever the number of vibrations of the individual notes are in some near relation to each other, as 1 to 2, 1 to 3, 2 to 3, &c., that is, where one string makes two, three, or four vibrations, while the other makes one, or accomplishes three, while the other accomplishes two or four; and the concord as the more perfect and pleasing the lower the terms of these ratios are. But, if on the contrary, the times of vibration, or number of vibrations in a given time, have not a loud, numerical ratio to each other, but one in which the terms are considerable, as 8 to 15, that is, one string executing fifteen vibrations, while the other executes only eight, then there is a discord, the impression on the ear is harsh and disagreeable. The whole of harmony consists in following out these laws; any combination of sounds which violate them cannot be agreeable. The pleasure of these harmonious sounds depends, according to Dr. Young, on a love of order and a predilection for a regular recurrence of sensations, primitively implanted in the human mind. Hence, when two sounds occur together, those proportions are most satisfactory to the ear which exhibit a recurrence of a more or less perfect coincidence at the shortest intervals. This same constitution of the human mind which fits it for the perception of harmony, appears also to be the cause of the love of rhythm, or of a regular succession of any impressions whatever, at equal intervals of time."—"The Elements of Physics," by Thomas Webster, M.A., p. 208.]

A combination of harmonious sounds is a chord, a succession of harmonious notes a melody, and a succession of chords harmony.

We have remarked in the last chapter that sounds may be expressed by numbers as well as by letters or names, and their relations to one another clearly exhibited. For this purpose, we may take the monochord or sonometer, C C', Fig. 201, an instrument consisting of a wire or catgut stretched over two bridges, F F', which are fastened on a basis, S S'; one end of the cord passes over a pulley, M, and may be strained to any required degree of weights, P. The length of the string vibrating may be changed by pressing it with the finger upon a moveable piece, H, which carries an edge, T, and the case beneath is divided into parts which exhibit the length of the vibrating part of the wire. The upper part of Fig. 202 shows a horizontal view of the monochord, the

The two large figures are formed by putting together four smaller plates, in one instance bearing the nodal lines, represented at I, and, in the other, at II. They may, however, be directly generated on one large plate of glass by holding it at *a*, touching it at *w*, and drawing the bow across it at *b*.

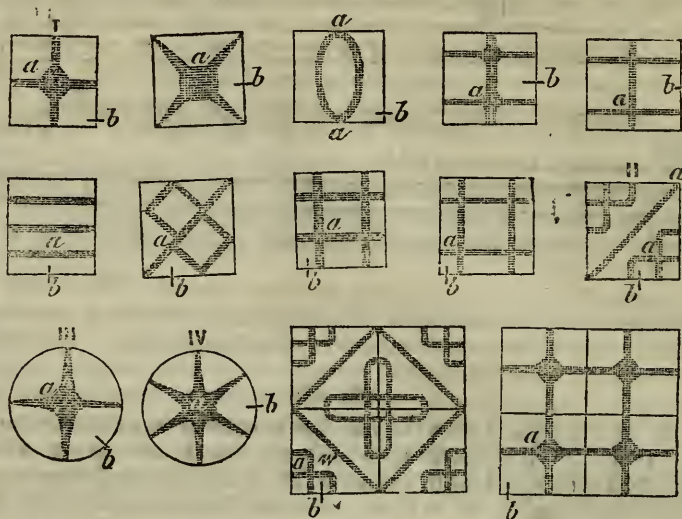


Fig. 202.

Circular plates, *a* in III., may be made to bear a four-rayed star, by holding them in the centre, drawing the bow at any point at *b*, and touching the plate at a point 45° distant from the bow; but if the plate be touched 30° , 60° , or 90° off, it produces a six-rayed star, Fig. IV.

Columns of air may be made to emit sounds by being thrown into oscillation, as in horns, flutes, clarionets, &c. In these, the column of air, included in the tube of the instrument, is made to vibrate longitudinally. The height of the note is inversely proportional to the length of the column, and therefore different notes may be obtained by having apertures, at suitable distances, in the side of the tube, as in the flute.

Two sounds may be so combined together that they shall mutually destroy each other's effect, and silence result. This arises from interference taking place in the aerial waves, the laws of which are those given in Chapter XXXI. The following instances will illustrate these facts.

When a tuning-fork is made to vibrate, and is turned round upon its axis near the ear, four periods may be discovered during every revolution in which the sound increases or declines. We may produce standing vibrations of the air within a closed tube, by bringing an oscillating body before the open mouth of the tube, so that it may produce such a tone, that the length of the tube is equal to $\frac{1}{4}$, $\frac{3}{4}$, $\frac{5}{4}$, &c., of the wave-length of the tone.

If we take two tuning-forks of the same note, *a* *d*, Fig. 203, and fasten a circle of cardboard, half an inch in diameter, on one of the prongs of each, and make one of the forks a little heavier than the other, by putting on it a drop of wax, and then filling a jar, *b*, to such a height with water, that either of the forks, when held over it, will make it resound, so long as only one is held, there will be a continuous note, without pause or interruption; but if both are held together, there will be periods of silence and periods of sound, according as the longer waves, arising from one of the forks, overtakes and interferes with the shorter waves, arising from the other.

Fig. 203.

[In order to throw the inclosed air into regular vibrations, or to make it resonant

with the sounding body, it is not indispensably necessary to bring a sounding body before the opening of a tube. Thus, in organ pipes there is a current of air flowing past the open end of the tube, breaking against the edges, and creating, by its impulses, waves that are reflected on the bottom, and interfere with the newly incident waves. Although these impulses are at first not quite regular, they are soon regulated by the accession of reflected waves, provided the tube sound well, so that regularly standing waves are formed, by means of which the air in the tube becomes resonant. The notes yielded in this manner by a tube, are of the same kind as those which must be given forth by another sounding body brought to the opening of the tube, for the purpose of inducing spontaneous sound in the enclosed air.—*Professor Muller's Physics and Meteorology, Lecture XVII.*]

Sounds undergo reflection, and may therefore be directed by surfaces of suitable figure. If, in the focus of a concave mirror a watch be placed, its ticking may be heard at a great distance in the focus of a second mirror, placed so as to receive the sound waves of the first.

On similar principles, also, whispering galleries depend. These are so constructed that a low whisper uttered at one point is reflected to a focus at another, in which it may be distinctly heard, while it is inaudible in other positions. The dome of St. Paul's Cathedral, in London, is an example.

[The principle of the whispering gallery at St. Paul's, may be easily understood, by referring to the accompanying diagram. If a sound, such as the tick of a watch, or a low whisper, emanates from the point A, it may proceed from A to C, and from C to B, by a number of lesser reflections from *d e*. C, *b a* alternately, terminating at B. Thus a sound that could not be conveyed directly from A to B, may be heard distinctly by accumulated reflection from several points in the circular surface, A C B.—W. T. K.]

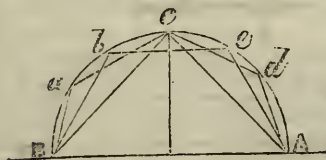


Fig. 204.

Echoes are reflected sounds. Thus, if a person stands in front of a vertical wall, and at a distance from it of about $62\frac{1}{2}$ feet, if he utters a syllable, he will hear a sound which is the echo of it. If there be a series of such vertical obstacles, at suitable distances, the same sound may be repeated many successive times. A good ear can distinguish nine distinct sounds in a second; and, as a sound travels 1,120 feet in the same time, for the echo to be clearly distinguished from its original sound, it must travel 125 feet in passing to and from the reflecting surface, that is, the reflector must be at least $62\frac{1}{2}$ feet distant.

Remarkable echoes exist in several places. One near Milan repeats a sound thirty times. The ancients mention one which could repeat the first verse of the *Æneid* eight times. On the banks of rivers—as, for example, on the Rhine,—sounds are often echoed from the rocks, rebounding from side to side.

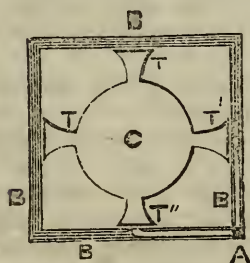


Fig. 205.

[Sounds are multiplied by reflection, and the knowledge of this fact is made use of in our large mercantile houses and other establishments, where messages are conveyed from one part of a building to another part, or even

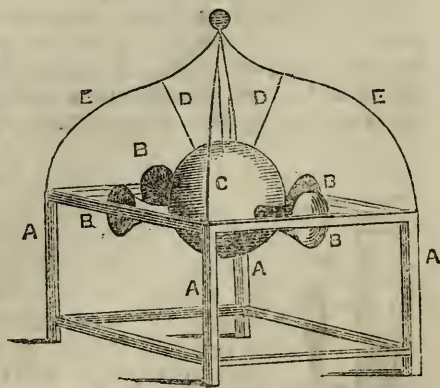


Fig. 206.

from one building to another, by means of tubes. It is probable that this was the means used by Roger Bacon, and others, to make persons, unacquainted with acoustics, believe

that inanimate figures spoke through their means. One of the most ingenious and celebrated of these scientific deceptions was that exhibited in Paris and London many years ago. It was invented by M. Charles, and styled the "Invisible Girl." Many solutions of this scientific enigma were attempted; but the following may be relied upon, as the Editor has many times acted the part of the "Invisible Girl." The apparatus consisted of a wooden frame (B B B. Fig. 205), which was supported upon four pillars, A A A A, Fig. 206). Through one of these pillars a tube passed underneath the floor to an adjoining room from which the "Invisible Girl" could see all that passed and hear all questions proposed, because the construction of the apparatus favoured it. To each pillar, A, was attached a bent wire, E, which terminated above in a point, and to each of these bent wires was attached a narrow silk ribbon or cord, D D, which supported a hollow copper ball, C, with four trumpets, T' T' T T, issuing from it at right angles. The peculiarity consisted in having the copper ball, which was supposed to conceal the "Invisible Girl," suspended by ribbons which were barely sufficient to support the weight of the ball. When a question was proposed, the sound passed through the mouth of one of the trumpets to the copper ball, and thence through another of the trumpets (T' or T'', Fig. 205), along canals in the frame (B) to the tube passing through the pillar, (A, Fig. 206), to the room in which the person was concealed. This apparatus was exhibited at the Royal Polytechnic Institution, London, many years ago.—W. T. K.]

Speaking-trumpets depend on the reflection of sound. The divergence is prevented by the sides of its tube; and if the instrument is of a suitable figure, the rays of sound issue from it, as seen in Fig. 207, in a parallel direction. Its efficiency depends on its length. It is stated that through such an instrument, from 18 to 24 feet long, a man's voice can be heard at a distance of three miles. Under common circumstances, the greatest distances at which sounds have been heard are usually estimated as follows:—The report of a musket, 8,000 paces; the march of a company of soldiers at night, 830 paces; a squadron galloping, 1,080; the voice of a strong man, in the open air, 230. But the explosions of the volcano of St. Vincent were heard at Demerara, 345 miles; and, at the siege of Antwerp, the cannonading was heard in the mines of Saxony, 370 miles.

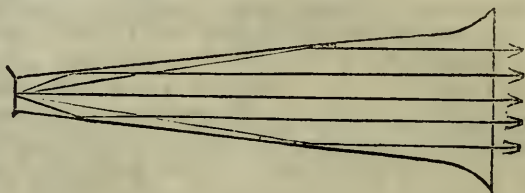


Fig. 207.

The hearing-trumpet is for the purpose of collecting rays of sound by reflection, and transmitting them to the ear.

["The art of ventriloquism appears to depend, in some degree, on the reflection of sound within the mouth. Professor Dugald Stewart attributed the talent of exciting the perception of articulate sounds, in such a manner as to give them the effect of emission from various distances and directions, wholly to deception and the power of imitation."—Moffatt's "*Boy's Book of Science*," p. 287.]

LESSONS IN FRENCH.

THE ADJECTIVE.

Adjectives which are not susceptible of Comparison.—Grammarians do not agree upon the adjectives which do not admit of the degrees of comparison; the principle which should be admitted as a guide in this difficulty is, that when an adjective expresses a qualification in a very or in the highest degree, it is better not to use it in the comparative or superlative form; such are the following: *Charmant*, charming; *mortel*, mortal; *éternel*, eternal; *suprême*, supreme; *immortel*, immortal; because a thing or person cannot be more or less charming, mortal, eternal, &c.

Adjectives of Dimension.—There is a difference in the construction of French and English sentences when speaking of the dimensions of a thing, that requires the attention of foreigners.

Instead of the verb *to be*, which is used in English, the verb *to have* is employed in French, and the preposition *of* is placed before the word which expresses the dimension; as in, This room is twenty feet long, *Cette chambre a vingt pieds de longueur*. The word which expresses the dimension may be a noun or an adjective; the noun can always be used, but not so with the adjective; for, speaking of depth and thickness, we would not say: This well is ten feet deep, *Ce puits a dix pieds de profond*; This wall is three feet thick, *Ce mur a trois pieds d'épais*. We should use the nouns *profondeur* and *épaisseur*.

When two dimensions are spoken of in the sentence, the preposition *sur*, *upon*, is placed before the second proposition; as in, This room is fifteen feet long and twelve feet wide, *Cette chambre a quinze pieds de longueur sur douze de largeur*. Finally, if the three dimensions are expressed, the conjunction *and*, *et*, is used before the last; as in, This room is sixteen feet long, twelve feet wide, and ten feet high, *Cette chambre a seize pieds de longueur sur douze de largeur et dix de hauteur*. Sometimes the sentence is constructed in English without the verb *to be* being used; as in, There is in this house a room twenty feet wide. Then the verb *to have* is not expressed in French,

and the preposition *of* is used twice, once before the numeral adjective, the second time before the word of dimension; as, *Il y a dans cette maison une chambre de vingt pieds de longueur*. The other dimensions should be expressed as above, with *sur* before the second and *et* before the last proposition. There is still another manner of expressing dimension in French, but as that we have just given is the most elegant and the most generally used, we deem it unnecessary to mention it. In comparative sentences, the English, to express a difference, turn their phrases in this way: She is taller than her sister by a whole head. But, *Elle est plus grande que sa sœur de toute la tête*, is the French construction, making use of *de*, *of*, instead of *by*.

The Adjective with the Article.—Adjectives expressing only modes and qualities are not preceded by the article, except in a few instances, which will be explained hereafter; thus we say, without an article, Men are often good or bad only for the reason that they have received good or bad examples, *Les hommes sont souvent bons ou mauvais par cela seul qu'ils ont reçu de bons ou de mauvais exemples*. But adjectives used as nouns are, like nouns, preceded by the article, if the case requires it; as, Fools invent fashions and wise men conform to them, *Les fous inventent les modes et les sages s'y conforment*. When a noun is accompanied by two adjectives expressing opposite qualifications, the article must be repeated before each adjective; as, The old and the new-raised soldiers are full of ardour, *Les vieux et les nouveaux soldats sont remplis d'ardeur*; A man who cares for his reputation ought to frequent good and avoid bad company, *Un homme qui est jaloux de sa réputation doit fréquenter la bonne compagnie et fuir la mauvaise*. The reason of this is, that adjectives opposite in signification cannot at the same time modify the same substantive; a soldier cannot be young and old at once, and company cannot be both good and bad. Then there is an ellipsis, in the two above examples, of the word *soldier* after *old*, and of the word *company* after *good*, and the existence of two nouns requires the use of the article before each, their meaning being definite.

But, if the qualifications expressed by the adjectives are similar, the noun being jointly modified by them, the ellipsis does not exist, and consequently the article is not repeated; as, The wise and pious Fenelon, *Le sage et vertueux Fénelon*. There being but one individual who is wise and pious.

When the qualifications, without being incompatible, are somewhat different, it is correct to repeat the article, although not indispensable; as, The sensible and ingenious Fenelon, *Le sensible et l'ingénieux Fénelon*. Here one of the qualities belongs to the mind, the other to the heart; but in general the *ear* must be consulted in cases similar to this, in preference to rules. Before adjectives prefixed to proper names, either to express their qualities or to distinguish the person spoken of from those who might bear the same name, the article is used; thus we say, The sublime Bossuet, *Le sublime Bossuet*.

The adjective preceding the noun shows but a distinct quality, but, when following it, points out the noun as a particular one among others like it. The above examples demonstrate the truth of this remark. When a superlative relative precedes a substantive, the article serves for both; as, The ablest men sometimes commit the grossest blunders, *Les plus habiles gens font souvent les plus grandes fautes*. But if it follows the substantive, the article must be repeated: *Les gens les plus habiles font souvent les fautes les plus grandes*.

When two or more superlatives modify a noun, the sign of the superlative, either relative or absolute, must be repeated before each adjective; as, It is equally the custom of the most barbarous and the most civilized people, *C'est également la coutume des peuples les plus barbares et les plus civilisés*, and not, *C'est également la coutume des peuples les plus barbares et civilisés*. We have seen, by the preceding rules, that when the article is used with the adjective, it always precedes it; but there is an exception.

The adjective *all*, *tout*, when employed with the article, always precedes it; thus we say, Everybody says that you are a rogue, *Tout le monde dit que vous êtes un coquin*.

Of Adjectives preceded by the Verb to be,

être, used impersonally.—Whenever an adjective is employed with the verb *to be*, *être*, used impersonally, it should be followed by the preposition *of*, *de*, although in other cases, that adjective might require another preposition; as in, It is difficult to learn French, *Il est difficile d'apprendre le Français*? It is pleasant to be acquainted with foreign languages, *Il est agréable de savoir les langues étrangères*; This language is difficult to learn, *Cette langue est difficile à apprendre*; This wine is pleasant to drink, *Ce vin est agréable à boire*. In the two first sentences, the adjectives *difficile* and *agréable* are used impersonally and take *de* after them; in the two last, they are not, and require to be followed by the preposition *à, to*.

Of the Adjectives A, Un.—A, Un, repeated or not with two or several Nouns united by the Conjunction And, Et.—The adjective *a, un*, is repeated before each noun, as well as the article *the*, unless the nouns designate two qualifications which belong to a single individual; as in, An Englishman, a Frenchman, an Italian, and a Spaniard, are easily recognised by manners and features, *On reconnaît facilement un Anglais, un Français, un Italien, et un Espagnol à son style et aux traits de son visage*.

A, Un, repeated or not with two or several Nouns separated by the Conjunction Or, Ou.—The adjective *a, un*, is repeated before each noun when separated by the conjunction *or, ou*, provided they have a different signification; but it is not repeated if the second noun is but the explanation of the first, in which case, if the nouns were not of the same gender, the adjective should agree with the first; as in, When I walk, I always hold a Virgil or a Tacitus in my hand, *Lorsque je me promène, j'ai toujours un Virgile ou un Tacite à la main*.

A, Un, repeated or not before two Adjectives united by the Conjunction And, Et.—*A, un*, is repeated before two adjectives united by *and, et*, whenever, on account of their signification, they cannot qualify the same noun, but it is not repeated if the two adjectives are used to qualify the same person or thing; as in, I saw this morning a small and a large house, which pleased me much, *J'ai vu ce matin une petite et une grande maison, qui me plaisent beaucoup*.

A, Un, repeated or not before two Adjectives separated by the Conjunction, Or, Ou.—When two adjectives separated by *or*, *ou*, precede the noun, *un* is repeated before each; but if they follow it, *un* is used but once; as in, The happiness of a people depends upon its having a good or bad administration, *Le bonheur d'un peuple dépend d'une bonne ou d'une mauvaise administration.*

Remark.—In proverbs, maxims, or sententious expressions, *un* is used or not; it is a matter of taste; as in, Too constant a happiness sometimes becomes intolerable, *Un bonheur trop constant devient souvent insupportable.*

Of A employed in English before a Noun qualified or not by an Adjective as the attribute of the Verb To Be.—Whenever a noun preceded by *a* is used in English as the complement or attribute of the verb *to be*, *un* is not expressed in French, unless the English noun should be qualified by an adjective or a qualificative expression, or the verb *to be* should have for its nominative the pronoun *ce*; as in, My father was a general, and my uncle an admiral, *Mon père était général et mon oncle amiral*; One of your brothers is a distinguished general, and the other an admiral of great reputation, *L'un de vos frères est un général distingué, et l'autre un amiral de grande réputation*, What is your father's profession? He is a physician, *Quelle est la profession de monsieur votre père? Il est médecin, or, C'est un médecin.*

In the first sentence, the names *général* and *amiral* are used as mere adjectives; no idea of individuality is attached to these words; the second sentence, on the contrary, points out the persons spoken of not only as occupying the ranks of general and admiral, but as being among those of the same rank, the one a general and the other an admiral, of a particular kind, and the adjective *un* serves to convey this view of the mind.

Remark.—Whenever the adjective *grand* is used with the following noun to designate a certain situation in the government of a country, the two words should then be united by a hyphen, as forming but one word, and *un* should not be expressed; as in, Mr. M** is a grand-officer of the legion of honour, *Monsieur M** est grand-officier de la légion*

d'honneur. The same remark applies to any expression of the same character.

Of A before a Noun or a Proposition used in Apposition in English.—Whenever *a* is used in English before a noun or an expression used in apposition to another, *un* is not expressed in French; as, The best coffee comes from Mocha, a town of Arabia Felix, *Le meilleur café vient de Moka, ville de l'Arabie heureuse.*

Of A placed in English after What, before a Noun, preceded or not by an Adjective.—*A* used in English after the pronoun *what*, before a noun or an adjective, is not expressed in French. What a beautiful morning! *Quelle belle matinée!*

Of A placed in English before a Noun expressing Measure or Weight.—*A*, used in English before a noun expressing measure or weight, is rendered in French by the article *the*: Corn sells for eight shillings a bushel, *Le blé se vend huit schellings le boisseau.*

Of A placed in English before a Word expressing a Period of Time.—When *a* is used in English at the end of a sentence, before a noun expressing any period of time, it is rendered in French by the preposition *by, par*; as in, My father earns ten dollars a week, *Mon père gagne dix gourdes par semaine.*

Of the Adjective A used in English before a Noun, preceded or not by an Adjective, in an Interrogative or Affirmative Sentence used Negatively.—Whenever an interrogative sentence used negatively is a mere form of language to express an affirmation, *a* is used in French as in English, and is expressed by *un*; as in, Have you not a knife? meaning, You have a knife, have you not? *N'avez-vous pas un couteau?* But if the sentence be intended to ascertain if really you have a knife or not, it becomes partitive, and *a* used instead of *any* is expressed by *de*; as *N'avez-vous pas de couteau?* If the sentence be affirmative instead of being interrogative, *a*, if used in English, should be expressed by *de* before a noun, and by *un* before an adjective; as in, No, sir, I have not a knife, *Non, monsieur, je n'ai pas de couteau.*

Of the Place of the Adjective A, Un.—*Un* is always placed before the noun which it qualifies, whether this noun is preceded or not by an adjective: I have a bird, *J'ai un oiseau.*

Exceptions. (1.) With the adjective *tout*, *un* is placed between that adjective and the noun which it qualifies; as, I have spent a whole evening at your father's, *J'ai passé toute une soirée chez votre père.* But if *tout* should be used as an adverb, meaning *entirely, quite, &c.*, the adjective *un* might be placed indifferently before or after it; as in, That is quite a different affair, *C'est une tout autre affaire, or, C'est tout une autre affaire.*

(2.) Whenever the nouns *monsieur, madame, and mademoiselle*, are used with the pronoun *tel*, to designate a person in a vague and indefinite manner, corresponding in English to the expressions, *Mister, Mistress, or Miss So-and-so*, the adjective *un* is placed in French between the above nouns and the pronoun *tel*; as, *Monsieur un tel; Madame une telle; Mademoiselle une telle.*

(3.) *A* used in English with the adjective *such*, always follows it; but in French it is placed before that adjective; as in, Such conduct is shocking, *Une telle conduite est choquante.*

Of Cases in which A or One is not expressed in French.—*A* or *one* is not expressed in French before the numerical adjectives *hundred* and *thousand*; as in, How many persons were there at the party last night? One hundred. *Combien de personnes y avait-il au bal hier soir? Cent.*

One, used as a pronoun in English is not expressed in French in sentences like the following: If you wish for a dog, I can give you a pretty one, *Si vous désirez un chien, je peux vous en donner un joli.*

Of Cases in which A may be expressed by the Article The in French.—There are a few cases in which *a* is expressed by the article *the* in French; as in, I wish you a good morning, or evening, *Je vous souhaite le bon jour, or, le bon soir* (idiomatic.) But we say, very properly: I wish you a pleasant evening, or morning, *Je vous souhaite une agréable soirée or matinée.* However, the former expressions are more elegantly used than the latter, *a* always implying an idea of peculiarity which does not suit the meaning of the nouns *head, nose, chin, &c.*, for a man has but one head, one nose, one chin, &c.

PRACTICAL LESSONS IN DRAWING.

FIFTH LESSON.

HAVING hitherto directed your attention towards the simplest rules of the art of drawing, and furnished you with illustrations according with them, and the proficiency you made in the art; we shall now give you more difficult exercises, which will be progressive. Do not be deterred from mastering them by their *apparent* difficulty, because, as you may be said to stand already upon the first step of the ladder you will have to mount, proceed with a firm determination to plant your foot upon the top step. Perseverance should be your constant watchword, and stimulate you to surmount any trifling difficulty that obstructs your path.

Before submitting the examples we have prepared for this lesson, it will be necessary to make a few observations upon copying.

We will suppose that you have to copy a drawing,—perhaps an architectural one. How would you commence? Most probably differently to your neighbour, who would also commence differently to his neighbour, and so on, unless guided by correct principles. Do not imagine that what we state is without foundation; it is perfectly true, for not long since we placed two drawings of the same subject before four pupils, and requested them to copy them, and each one commenced differently. One of them began at the right hand side, the other at the left, another at the top, and the fourth in the centre of the drawing. What could illustrate more forcibly than these blunders, that attention to the rules of the art is *absolutely necessary*? You might as well expect to build a house by telling one man to make the back, another the top, and another the lower windows, without furnishing any of them with a design, measurement, or idea of the style; when your builder, without a design, came to fix the windows, he would be in as great a mess as you will be, if not guided by principles and rules in the practice of the art of drawing.

You ask, "How am I to commence?" and to this question we will at once reply. First, enclose a certain space, by means of four lines, if for a landscape; or by an

oval or circular line, if for a portrait, &c.: this is called *the boundary line of the drawing*, and is used to confine a certain portion of a landscape or other subject. The importance of attending to this rule will be obvious to every person; and when we treat hereafter of sketching from Nature, you will then find how essential it is to adopt this method. When the boundary-line is formed, your next care should be to determine the relative positions of the principal objects, points, or features, &c.; and if you have attended to the instructions given in the former lessons, you will not have much difficulty in doing so by means of faint lines and dots. In a landscape you will have to fix the height of the horizon, which should be done by first placing a dot at each side of the boundary-line, and then, if you have judged the distance correctly, uniting the two by a faint line drawn through the picture; this is called *the horizontal line*. When that has been done, determine the nearest *conspicuous* object to the boundary line, its height, width, and relative position to the horizontal line, and other objects; then fix the position of the trees, distance, and foreground, by means of faint outlines, or dots, or both, taking care to observe their relative situations, inclinations, and measurements are regulated by their proximity to the boundary, horizontal, and base lines of the picture; the last-mentioned line, being the bottom or lower boundary line of the drawing.

In fig. 8 (p. 172, vol. v.) you were directed to draw a line perpendicular to the horizontal ones, this was done for the purpose of enabling you to judge the relative distances of the several angles of the pyramid from each other, and you will find it very useful to draw a line through the centre of any object that you have to copy, because it serves as a guide to the proper disposition of the several other parts. Of course, as you become more and more proficient in the art, *this will not be always necessary*.

We will now commence some practical illustrations of the preceding remarks. You are required to draw fig. 20, which is a centre-piece for the border or an ornamental panel. Fig. 21, is a diagram illustrating the method of doing so, which is thus. First draw three horizontal lines,

a b, c d, e f, and bisect them with the perpendicular line *g h*. You have only to determine the relative distances of each



Fig. 20.

point by means of dots, and to draw the curved and straight lines faintly, as shown in fig. 21, and afterwards to rub out the

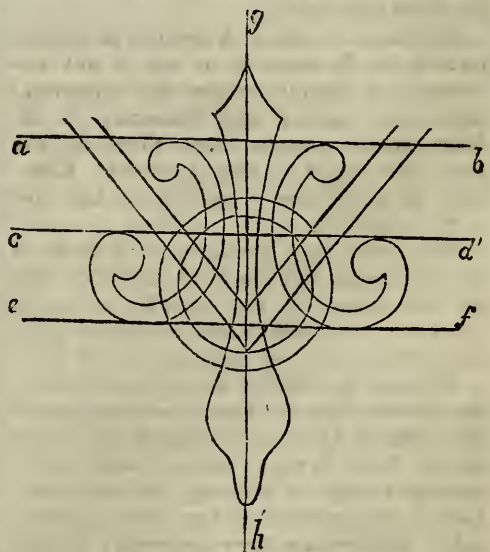


Fig. 21.

superfluous lines, and strengthen the outline by broad touches with an H B pencil.

We have found it an excellent plan to cut the Indian-rubber used for rubbing out architectural and fine drawings in a triangular shape, because the angles enable us to remove very small lines, or dots.

The Indian-rubber should not be more than 1-4th to 3-8ths of an inch thick.

Our next example is of a different character, being the outline of an antique vase (fig. 22). In drawing this figure, a

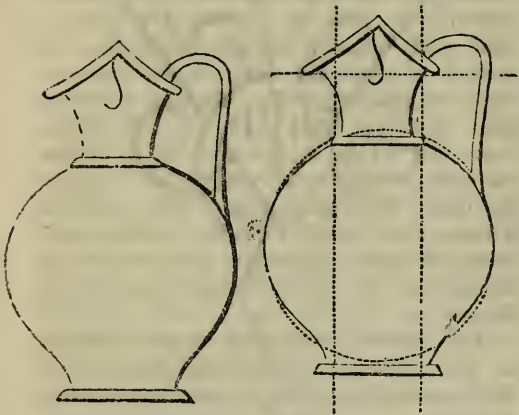


Fig. 22.

Fig. 23.

circle is first of all drawn, and then it is divided by two perpendicular lines, (as shown in fig. 23), and a horizontal line drawn above the circle. These lines are sufficient to enable the pupil to construct the figure with ease.

Our next exercises are taken from antique vases, and given without any diagrammatic illustrations to enable the pupil



Fig. 24.

to construct them, because, having already given ample directions, we wish pupils to

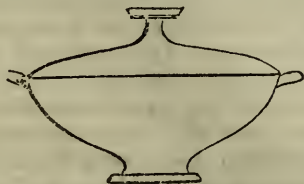


Fig. 25.

think for themselves, so as to be able to act at times without the aid of an instructor.

BOTANICAL GEOGRAPHY.

(Concluded from page 353.)

THERE are many plants which can accommodate themselves to the most diverse climates and localities; and therefore ascend from the plains close to the boundary of vegetable life on the highest mountains. But it is the general law in these cases for such plants to be singularly modified in appearance and anatomical structure as they ascend. The spring gentian, *Gentiana verna*, is one of the exceptions, which Raymond found unaltered at all heights in the Pyrenees.

Trees, plants, and bushes, of humbler growth, which occur on the plains and at great heights, are usually much smaller in the latter situation. The leaves, and everything green about them, dwindle with the increased elevation; and the pure, well-defined green is exchanged for an ill-defined light yellow. Singular enough, those parts which seem most capable of resisting cold, as the leaves and stalks, are uniformly subjected to a diminution of their vital functions; while the flowers remain of the same size, are never deformed, and become more dense and richer in their colours. While the *Myosotis silvestris* becomes stunted, its flowers assume an intense blue, the admiration of the traveller. The flowers of the pale primrose have a much deeper colour on the top of the Faulhorn, while the plant itself is much smaller than its congener on the Swiss plains. The observations of M. Parrot, among others, are to this effect on the flora of the Caucasus, of Ararat, the Swiss and Italian Alps, and the Pyrenees. The arctic flora is similarly distinguished.

The preceding references to different climatic states are, however, perfectly inadequate to explain the phenomena of vegetable distribution. While an analogy is often observable between the plants of different regions under corresponding circumstances of latitude, elevation, and soil, the species are generally found to be different; and usually the botanical character of countries not widely apart from each other, is totally different, though under the same parallels.

Some plants are entirely confined to one side of our planet. The beautiful genus *Erica*, or heath, of which there are

upwards of 300 species, occurs with breaks over a narrow surface, extending from a high northern latitude to the Cape of Good Hope. But the whole continent of America does not contain a single native specimen; nor has a *Pœnia* been found in it, except a solitary one to the west of the Rocky Mountains. On the other hand, the New World contains many families, as the *Cacti*, which are not found naturally in the Old.

Some plants occur in a single specific locality, frequently a contracted area, and nowhere else. The beautiful *Disa grandiflora* is limited to a spot on the top of the Table Mountain at the Cape; and the celebrated cedar of Lebanon appears to be restricted in its spontaneous growth to the Syrian mountains. The small island of St. Helena has an indigenous flora, with a few exceptions different from that of the rest of the globe.

Mountain chains of no great width very commonly divide a totally distinct botany. There is a marked difference in the vegetation of the Chilian and opposite side of the Andes, though the climate as well as the soil is nearly the same, and the difference of longitude very trifling. In North America, two completely different classes of vegetation appear on the two sides of the Rocky Mountains. A variety of oaks, palms, magnolias, azaleas, and magnificent rhododendrons occur on the eastern side, all of which are unknown on the western, the region of the giant pine.

The distinct vegetation possessed by various parts of the globe, has led to its division into botanical kingdoms, or phytogeographical regions, named in general after the genera that are either peculiar to them, or predominant in them. The arrangement of M. Schouw, which is usually adopted, discriminates twenty-five great provinces of characteristic vegetation upon the surface of the earth.

In constituting any portion of the globe into a phytogeographical region, M. Schouw has proceeded upon the following principles:—1. That at least one half of the species should be indigenous in it. 2. That a quarter of the genera should also be peculiar to it, or at least should have a decided maximum. 3. That individual families of plants should either be

exclusively confined to the region, or have their maxima there.

The phenomena of botanical geography and the facts of geology are mutually illustrative. The existing dry land having been upheaved above the waters at different epochs, it may be reasonably inferred that each portion on its emergence received a vegetable creation in harmony with its position. The ultimate constitution of the general surface into different botanical kingdoms would hence follow, each of which has preserved its primitive features, while adjoining, and even far distant foci, have to some extent intermingled their respective products, under control of the natural agencies of diffusion.

The agents that involuntarily officiate in the diffusion of vegetable products are the atmosphere, the waters, and many animals.

1. The impulsion of the atmosphere in its calmest state, is quite sufficient to transport to considerable distances seeds furnished with downy appendages or winglets, as is the case with many plants, with the minute sporules of cryptogamia, which are light as the finest powder. When ordinary breezes convey the sand-dust of the Sahara a thousand miles or more from the desert, it may be conceived that seeds, which are comparatively heavy, are borne far from home by the hurricane. Two Jamaica lichens, which had never been seen in France before, were found by De Candolle growing on the coast of Brittany, the offspring of sporules which had been swept over the Atlantic.

2. The mountain torrent washes down into the valley the seeds that have accidentally fallen into it, or have been swept away by its overflows; and hence the plants of the High Alps occur on the plains of Switzerland, which are entirely wanting in France and Germany. Rivers answer the same purpose more extensively, and also the oceanic currents. The nicker-tree, one of the leguminous tribe, has been raised from seed borne across the Atlantic by the Gulf stream.

3. Animals of the sheep and goat kinds, with the horse, deer, buffalo, and others, widely disperse several species of plants, the seeds of which, furnished with an apparatus of barbs and hooks, adhere to

their coating. Seeds also of various kinds pass through the digestive organs of birds, uninjured as to their vitality. The little squirrel buries the acorn in the ground for winter provender, and sows an oak, if prevented from returning to the spot.

Plants capable of extended naturalization, and serviceable as articles of food or luxury, have been widely disseminated by the human race in their migrations. The cerealia afford a striking example. These important grasses known to the ancients, wheat, barley, oats, and rye, were the gifts of the Old World to the New. They are also importations into Europe; but the loose reports of the ancients and the diligent researches of the moderns alike leave us in ignorance of their native seat. Probability points to the conclusion that they have spread from the neighbourhood of the great rivers of Western Asia, the primitive location of the human family; and it is not impossible that in that imperfectly explored district, or further east on the Tartarian table-land, some of the cereals may yet be found growing spontaneously. The first wheat sown in North-America, consisted of a few grains accidentally found by a negro slave of Cortes, among the rice taken for the support of his army. In South America the first wheat was brought to Lima by one of the early colonists, a Spanish lady, Maria d'Escobar. An ecclesiastic, Jose Rixi, was the first to sow it in the neighbourhood of Quito.

Maize, or Indian corn (*Zea mays*), has been dispersed in the Old World from the New; and also a more important product, the potato (*Solanum tuberosum*), the use of which now extends from the extremity of Africa to Lapland. In Chili, the native country of the plant, it occurs at present in a wild state. The Spaniards imported it into Spain, and from thence it was communicated to Italy. It was first made known in England at a subsequent period from Virginia, having been received there from the Spanish colonists in South America, as it is not a native of intervening Mexico.

The grape-vine, so extensively spread over Europe, is probably not indigenous in any part of it. It chiefly owes its diffusion there to the Romans, who received it from the Greeks, to whom it most likely

immediately came from the country between the Black and Caspian Seas. The Romans introduced most of the finer European fruit-trees, some from Africa, as the pomegranate, but the great majority from Western Asia, as the orange, fig, cherry, peach, apricot, apple, and pear. A variety of the plum, the damson, or damascene, came from the neighbourhood of Damascus during the Crusades. The name of the damask-rose points to the importation of the plant from the same quarter into Europe.

The ocean as well as the land has different botanical regions; and changes of the vegetation are observed with the depth analogous to the variation of terrestrial plants with the height. Marine vegetation seems to have its vertical extent determined by the subaqueous range of light, which varies with the power of the sun and the transparency of the water.

SCIENTIFIC FACTS.

PROFESSOR FARADAY, in a recent lecture before the Royal Institute of England, upon the Magnetic Forces, made the following interesting announcement:

A German astronomer has for many years been watching the spots on the sun, and daily recording the result. From year to year the groups of spots vary. They are sometimes very numerous, sometimes very few. After awhile it became evident that the variation in number followed a descending scale through five subsequent years, and then an ascending scale through five subsequent years, so that the periodicity of the variations became a visible fact. While our German friend was busy with his group of sun-spots, an Englishman was busy with the variations of the magnetic needle. He, too, was a patient recorder of patient observations. On comparing his tabular results with those of the German astronomer, he found that the variations of the magnetic needle corresponded with the variations of the sun-spots — in the years when the groups were at a maximum, and so on through their series. This relation may be coincident merely, or derivative; if the latter, then do we connect astral and terrestrial magnetism, and new sources of science are open to us.



"Then came hot July, boiling like to fire,
That all his garments he had cast away,
Upon a lyon raging yet with ire
He boldly rode, and made him to obey;
(It was the beast that whilom did forray
The Nemeæan forest, till the Amphitronide
Him slew, and with his hide did him array);
Behind his backe a sithe, and by his side
Under his belt he bore a sickle circling wide."

SPENSER.

WHILE the glittering dew hangs upon
the fragrant flowers, and humble blades of

grass, and the skylark's wild lay so clear
and loud resounds

"O'er fell and fountain sheen
O'er moor and mountain green,"

let us hie away to the meadows bespangled
with wild flowers, and admire the beauties,
aye, the glories of Nature.

Listen to the bleating sheep, and cack-
ling poultry,

"And shepherd's pipe, and song of blooming
maid,
Quick as she turns the odour-breathing
swathes
Of new-mown hay,"

and tell me is not this a treat the slumbering inmates of you vine-covered cot would do well to enjoy? They know not the beauties of Nature who lead a sluggard's life. They lose the fragrance of the morning breeze that invigorates the frame; the beauties of the countless insect world bursting into life; the music of the gurgling brook or silvery sparkling stream; the echoing notes of a thousand throats, that resound from grove to hill; the floods of golden light pouring from the glorious sun and relieved with every gradation of colour in the ever-changing clouds; and the spiral wreaths of azure smoke that upward tower from amid yonder cluster of dark waving trees where the quiet hamlet lies.

If we climb the castled cliffs, or rude
craigs, time-worn and channelled by the
floods,

"Whence Nature's universal face
Illumined smiles with new-born grace,"

we shall discover fresh charms to entice
us to ramble again over the dewy meads,
when after sweet slumbers

"fresh and free

The soul pours forth its orisons with zeal
To the great Spirit of Eternity,
That was, and is, and shall for ever be."

In the Alban Calendar, July was called *Quintilis* to denote its numerical position,—being, in fact, the fifth month of the old Latin year; whereas now it is our seventh. It was sacred to Jupiter, and consisted of thirty-six days, which Romulus reduced to thirty-one, and Numa Pompilius to thirty, but Julius Cæsar restored the day which Numa had taken away from it. In consequence of the alterations made in the calendar by Numa, July became the seventh month in the year, but retained the name of *Quintilis*, until Mark Antony changed its name to *Julius*, as a compliment to Julius Cæsar, who had done so much to improve the calendar.

The synonyms of the month are as follows: in Latin, *Julius*; French, *Juillet*; Italian, *Luglio*; Portuguese, *Julho*; and Saxon, *Heu monath*, *Hey monath*, or *Hay month*, because the hay-harvest of our

Saxon ancestors was held in this month. It was also called *Maed monath*, because at this season the meadows are covered with bloom.

The allegorical representation of the month consisted of a young man in a light jacket eating cherries; his face and chest sunburnt, and his head surmounted by a wreath of wild thyme. He bore a scythe on his shoulders, symbolical of the hay-harvest, while an ample bottle hung at his girdle, and at his side was the sign of *Leo*, the lion, alluding to the sun entering that sign on the twenty-third of the month.

As our space obliges us to be brief, we shall take a cursory glance at the chronology of the month before examining the beauties of its natural history.

THE FIRST DAY.—In 1582 James Crichton, commonly called "the Admirable," was assassinated by the Prince of Mantua. In 1690, was fought the famous battle of the Boyne; and in 1798 the battle of the Nile was fought.

THE SECOND DAY.—In 1489, Archbishop Thomas Cranmer was born, at Aslacton, in Nottinghamshire; and in 1724 Friedrich Gottlieb Klopstock was born at Quedlinburg. Goethe remarked that "German literature was greatly indebted to Klopstock," but times have changed, and his effusions, although much admired, are tedious to read throughout.

THE THIRD DAY.—This day commences what are termed the Dog-days, which continue until the eleventh of August. The name was given in reference to the heliacal rising of the constellation of Canis Major, called Sirius or the Dog-star, which was formerly thought to make the sea boil, dogs to go mad, wine to turn sour, animals generally to languish, and to originate fevers and cholera. The name applied to this period probably took its origin from a festival having been formerly held at Argos, expressly instituted for the killing of dogs during this season.

In 1799, died William Curtis, the author of the "*Flora Londinensis*," and originator of the "*Botanical Magazine*." He was also an excellent entomologist and ornithologist.

THE FOURTH DAY is dedicated to *St. Ulric*, bishop of Augsburg; formerly the people brought fish,

"Both carpes and pykes and mullets fat,
His favour here to win."

and the fish thus offered was sold at the altar for the benefit of the church.

The Translation of *St. Martin* is fixed upon this day; and although the day is retained in the calendar of the Church of England, yet it is not observed.

In 1776, the declaration of American Independence was received and adopted by thirteen of the United States.

THE FIFTH DAY.—In 1685, the battle of Sedgemoor was fought near Bridgewater, in Somersetshire.

THE SIXTH DAY.—In 1755 was born John Flaxman, the eminent sculptor.

THE SEVENTH DAY is dedicated to *St. Thomas à Becket*, Archbishop of Canterbury, who was murdered at the altar of Canterbury Cathedral the twenty-ninth of December, 1170.

In 1816, Richard Brinsley Sheridan, the eminent poet, dramatist, and statesman, died in poverty.

THE EIGHTH DAY.—In 1533, Ariosto, the celebrated poet, died at Ferrara.

THE NINTH DAY.—In 1442, Christopher Columbus, the discoverer of America, was born.

THE TENTH DAY.—In 1509, John Calvin, the Reformer, was born at Noyon, in Picardy, where his father, Gerard Calvin, carried on the trade of a cooper.

THE ELEVENTH DAY.—In 1732, Joseph Jerome Le François De Lalande, the celebrated astronomer, was born at Bourg, in the department of Ain.

THE TWELFTH DAY.—In 1536, Erasmus died at Basle, aged sixty-nine. His "Colloquies," first published at Basle in 1522, are amusing, and powerfully written in some parts.

THE THIRTEENTH DAY.—In 1718, William Penn, the Quaker, the founder of the city of Philadelphia, died, aged seventy-four.

THE FOURTEENTH DAY.—In 1728, the celebrated anatomist and surgeon, John Hunter, was born at Long Calderwood, in Kilbride, near Glasgow.* In 1755,

* For a sketch of the Life of Hunter, see vol. iii. of *Family Tutor*, p. 117. We may remark that much doubt exists as to the date of his birth. In our former article it is fixed in February, but we have since been informed that it is now generally supposed to have been on the fourteenth of July.

Mrs. Siddons, the celebrated tragic actress, was born. In 1789, the Bastile of Paris, was stormed and destroyed by the people, a preliminary to the other outrages that were afterwards committed.

THE FIFTEENTH DAY is dedicated to *St. Swithin*, who lived in the ninth century. He was the deviser and originator of tithes in England, and the priest of king Egbert. Being very pious and learned, he was created bishop of Winchester, and, dying in the year 865, was canonized by the pope. He requested that he might be buried in the open churchyard; which was a singular request, inasmuch as the bishops were generally buried in the chancel of the minster. The story runs, that the monks wishing to translate the remains of the saint, on his being canonized, resolved to do so on the 15th of July, with a solemn procession and great pomp, but as it rained violently on that day and the forty days succeeding, they looked upon it as a mark of disapprobation of the saint, and erected a chapel over his grave instead, at which many miracles are said to have been performed. Ever since then, a popular notion has prevailed that if it rains on St. Swithin's day, there will be rain for the forty ensuing days.

In 1839, the Chartist riots took place at Birmingham, when between £30,000 and £40,000 worth of damage was done by the rioters.

THE SIXTEENTH DAY.—In 1723, Sir Joshua Reynolds was born at Plympton, St. Mary, Devonshire: as a painter, he stood unrivalled in his day, and did much to improve the art. It has been said of him, that he "exalted portrait to the dignity of history;" and Northcote remarks that; "to the grandeur, the truth, and simplicity of Titian, and to the daring strength of Rembrandt, he has united the chasteness and delicacy of Vandyck."

THE SEVENTEENTH DAY.—In 1674, Dr. Isaac Watts, the great Nonconformist divine, was born at Southampton.

THE EIGHTEENTH DAY.—In 1761, Thomas Sherlock, an eminent prelate of the English church, died, aged eighty-three years. He was bishop of London in 1748, and is known as the author of "The Use and Intent of Prophecy:" and in 1374, Francesco Petrarca, or Petrarch,

died at Arqua, near Padua, in the seventieth year of his age. He was one of the most celebrated Italian poets as his works testify, particularly the sonnets to Laura de Noves, and his canzone, or "Ode to the Virgin," with which his poetry about Laura closes.

THE NINETEENTH DAY.—In 1674, Rembrandt Van Rhyn, a celebrated painter and engraver, died.

THE TWENTIETH DAY is dedicated to *St. Margaret*, an Italian virgin, who was martyred in 278. Although the name is retained in our calendar, the day is not kept. In 1807, a meteorolite fell, in Constantinople, which destroyed several houses.

THE TWENTY-FIRST DAY.—In 1796, Robert Burns, the poet, died, aged thirty-seven. His poetry was well suited to gain popularity.

THE TWENTY-SECOND DAY is dedicated to *St. Mary Magdalene*. In 1706, the union of England and Scotland took place.

THE TWENTY-THIRD DAY.—In 1588, "The English Mercurie" was published, and is supposed to be the first English newspaper issued.

THE TWENTY-FOURTH DAY.—In 1704, the Prince of Hesse d'Armstadt, who commanded 1,800 men, English and Dutch, took possession of Gibraltar. In 1709, Insurances were first established in London; but Insurance policies were, however, first used in Florence, in 1523.

THE TWENTY-FIFTH DAY is dedicated to *St. James the Apostle*, but has long ceased to be observed. Formerly the Catholic priests blessed apples upon this day, and a popular belief prevailed that whoever eat oysters on this day, would not want money for the remainder of the year. In 1849, the first stone of the Portland Breakwater was laid by His Royal Highness Prince Albert.

THE TWENTY-SIXTH DAY is dedicated to *St. Ann*, the mother of the Virgin Mary. In 1830, the disturbances in Paris commenced and lasted for several days, ending in the abdication of Charles X. and the acceptance of the crown of France by Louis Philippe.

THE TWENTY-SEVENTH DAY.—In 1747, died the Rev. Nicholas Tindal, the translator of "Rapin's History of England," which he also continued.

THE TWENTY-EIGHTH DAY.—In 1835, Fieschi, made an attempt against the life of Louis Philippe and his three sons as they rode along the line of National Guards, on the Boulevard du Temple. The machine exploded, wounding Fieschi, and killing and injuring upwards of fifty persons.

THE TWENTY-NINTH-DAY.—In 1893, William Wilberforce, the eminent philanthropist, and great promoter of the abolition of the slave-trade and slavery, died, aged seventy-four years.

THE THIRTIETH DAY.—In 1771, Thomas Gray, the poet, author of the "Elegy in a Country Church-yard," died in the fifty-fifth year of his age.

THE THIRTY-FIRST DAY.—In 1556, Ignatius Loyola, the founder of the order of Jesuits, died at Rome, aged sixty-five years.

Occasional refreshing showers, and the intense heat of July, have made plants thrive in the gardens, in the lanes, on the walls, and in the woods. The country looks beautiful, the ferns rustle, and

"Blue bells* wave tremulous. The mountain thymet
Purples the hassock of the heaving mole,
And the short turf is gay with tormentils,[†]
And bird's foot trefoil,[§] and the lesser tribes
Of hawkweeds,^{||} spangling it with fringed stars."

A gorgeous array of flowers, wild and cultivated, pour forth their fragrance into the summer breezes, and delight us with their varied hues, as well as with their grateful perfumes.

Did time permit, we might take a survey of the floral beauties of the month, in the fields and gardens. In former days, our delight was to examine the "alphabet of the angels," as flowers are poetically called. As Cowper expresses himself:

"I have loved the rural walk through lanes
Of grassy swarth, close cropped by nibbling sheep,
And skirted thick with intertexture firm
Of thorny boughs; have loved the rural walk
O'er hills, through valleys, and by river's brink."

Observe the beautiful damask rose (*Rosa Damascena*); the yellow rock rose (*Cistus helianthemum*), and the China rose hibiscus (*hibiscus rosa Sinensis*). How graceful their flowers look intermixed with

* *Campanula rotundifolia*. † *Thymus serpyllum*.

‡ *Tormentilla erecta* § *Lotus peregrinus*.

|| *Hieracium auricula*.

the green leaves, and other flowers close at hand. There is the musk mallow (*Malva moschata*); the sweet lavender (*Lavandula spica*),

“— whose spikes of azure bloom,
Shall be erewhile in arid bundles bound,
To lurk amidst the labours of the loom,
And crown her kerchiefs clean with mickle rare
perfume.”

the marvel of Peru (*Mirabilis jalapa*); the Japan lily (*Lilium Japonicum*); the Martagon lily (*L. chalcedonicum*); the stately hollyhock (*Althæa rosa*); the elegant dyer's coreopsis (*Calliopsis bicolor*); and the whorl-leaved coreopsis (*C. verticillata*).

What a beautiful border of pinks and carnations this is. Here is the tree pink (*Dianthus arboreus*); the China pink (*D. Chinensis*); and many other varieties including the clove pink, or carnation (*D. caryophyllus*); the alpine (*D. alpinus*); the rock (*D. petræus*); and above,

“—the wild pink† crowns the garden wall,
And with the flowers are intermingled stones
Sparry and bright, rough scatterings of the
hills.”

Let us away to the fresh meadows, and shady lanes, to get a glimpse at the wild flowers. We shall find the bog-pimpernel (*Anagallis tenella*); and the bog-asphodel (*Narthecium ossifragum*) with its yellow flowers on yonder heath, where we may perchance discover the ling (*Calluna vulgaris*), with pretty small flowers: and the sun-dew (*Drosera rotundifolia*).

This is a pleasant lane, 'tis shady, and fragrant with the perfume of wild flowers. Look in the hedge; that plant with the large pale blue star-shaped flowers, is pale blue succory, or blue endive (*Cichorium intybus*), sometimes called chicory. By its side is the hedge wound-wort (*Stachys sylvatica*), so frequently called clown's-heal-all, because it was, and is, often employed to staunch blood. The bell-shaped flower, with its dark green leaves, is the thorn-apple (*Datura stramonium*), the fruit of which looks so elegant when dissected or skeletonized.† The extract from the expressed juice of the leaves is employed by medical men as

a narcotic and stimulant, especially in spasmodic asthma. The elder (*Sambucus nigra*), which flowered last month, is now becoming laden with berries, so much prized by British housewives for making wine. Its leaves make a useful ointment, its young shoots a pickle, its flowers distilled with water afford a cosmetic wash, and the pith of the tree is used by the philosopher in his electrical experiments.*

We have chatted in our ramble over the various plants with which Nature has adorned our hedges and heaths, until we have entered upon the busy scene of hay-making,—always a source of pleasure to the young, and even to the aged, who delight to tell their oft-told tales of love, whispered at eve after the well-filled wagons had been carried to the yard to increase the snug stacks of sweet new-mown hay. “Haymaking,” says William Hone, in his “Year-book,” “is one of the most pleasing occupations of an English summer. The bright green of the smooth mown fields, bordered by ‘hedge-row elms,’ the sweet smell of the new hay, the bustle and merry songs of the busy hay-makers, and the waving uncut crops, are to the peaceful mind of a thinking observer really charming. In the hay-field the master distributes his men with the same attention to their abilities as the manager of a theatre casts the characters of a play among his performers. The younger and less experienced are set to rake the hay up into ridges, called in Dorset ‘wales,’ or to put it up into cocks; some of that numerous class of labourers who have more strength than wit are sent to pitch or unload; the next ‘grade,’ as brother Jonathan says, is that of the loader, who must be a man of some little talent, to build the load upright, and make it firm by properly putting in the binding masses at the corners; but the highest rank is that of the rick or stack-maker, who, besides having a proper knowledge of the mathematical lines under which hay-stacks are commonly comprehended, must be a man of activity and strength. The ground shape of the rick is either a circle or a parallelogram, which is to be

* *Dianthus campestris*.

† For the method of making plant-skeletons, see *Family Friend*, vol. ii., p. 193 (Old Series); and for the grouping and list of plants, see vol i. *Family Friend* (New Series), p. 144.

* For the method of constructing elder pith balls, see *Family Friend* (new series), vol. i. p. 140; and for the experiments, see *Family Friend* (new series), vol. ii. p. 283, and 284.

correctly kept; the rick must be upright, rounded out in the middle, and then go off into a cone or pyramid; and the rick-maker must so fix its size that it may take all the hay intended to be put into it, without spoiling its shape, and without waste or want; or, in the expression of the hay-makers, 'with none to leave and none to lack.'

The song-birds of our groves are most of them silent now, but the soft notes of their young are heard far and near. The gold-crested wren (*Regulus cristatus*); the stone curlew (*Ædicnemus crepitans*); the bittern (*Ardea stellaris*); and the little fat quails are occasionally seen. Besides these we have the linnet (*Linaria linota*); the white-throat; the red-start (*Sylvia phœnicurus*); the nightingale (*S. luscinia*); the blackcap; the red-breast (*S. rubecula*); the green-bird (*Fringilla chloris*); the chaffinch (*F. spiza*); the thrush (*Turdus musicus*); and the blackbird (*Merula vulgaris*.)

The disciple of Izaak Walton may often be seen strolling towards some quiet spot with his fishing-tackle in hand, and his hat ornamented—in his opinion at least—with sundry lines and artificial flies, for he knows that the trout (*Salmo fario*); the grayling (*Coregonus thymallus*); and the chub (*Leuciscus cephalus*), rise at flies and promise a good afternoon's sport. Then the juveniles love to get those pugnacious little fish, the sticklebacks (*Gasterosteus aculeatus*), and watch them fight in a glass-bowl.

The entomologist searches for the wood-leopard moths (*Zenzera æsculi*); the lackey-moth (*Clisiocampa neustria*); the drinker-moth (*Odonestus potatoria*), and the vapourer moth (*Orgyria antiqua*.) Among the butterflies he will no doubt find the silver streak (*Argynnis paphia*); the small ringlet (*Hipparchia cassiope*); the gate-keeper (*H. tithonus*); the large copper (*Lycæna dispar*); the purple Emperor (*Apatura iris*); and the honeysuckle butterfly (*Limenitis camilla*.)

The quadrupeds of the month are the common swine (*Sus scrofa*); the peaceful cow (*Bos taurus*); and the wily fox (*Canis vulpes*.)

The reptiles are the vipers (*Vipera berus*); the toad (*Bufo communis*); and the edible frog (*Rana esculenta*.)

In our forthcoming rambles we shall dwell more particularly upon some specimens of the natural history of the month than upon others, so as to impart a greater amount of knowledge than we have hitherto done; but in order to do so, we must necessarily curtail the chronological portion. We wish each pupil to exclaim, when he has finished his ramble in the month,

"I have felt
A prescience that disturbs me with joy
Of elevated thoughts; a sense sublime."

DATES.

THE great difficulty of treasuring up historical incidents, is surmounted by fixing in the mind some of the most important dates, and connecting with them other and great events, which are always retained easily in the memory. The following furnish some very interesting eras to the student, and are worthy to be remembered. They may be separated into two divisions—Ancient and Modern.

ANTE AND POST DILUVIAN.

The calling of Abraham	(B. C.) 1921
Escape of the Israelites from Egypt	1492
Building of the Temple	1004
Battle of Marathon	490
Reign of Alexander	336
Destruction of Carthage	146

Modern history is divided into early, middle, and recent. Perhaps the first remarkable epoch in early history is the reign of Constantine the Great (A. C.)	306
Fall of the Roman Empire	401
Mahomet's flight from Mecca to Medina (called the Hegira)	622
Charlemagne crowned Emperor of Germany	800
Greenland discovered by the Norwegians	982
Landing of William the Conqueror in England	1066
The end of the Saracen Empire	1258
Constantinople taken by the Turks	1453
America discovered by Christopher Columbus	1492
Abdication of the Emperor Charles	1555
Restoration of Charles II.	1660
Revolutionary War in America	1776
Bonaparte dethroned	1814

THE TUTOR AND HIS PUPILS.

[APPENDIX.]

Editor's Address.—London. 69, Fleet-street. The Editor of the "Family Tutor."

 The Appendix of the FAMILY TUTOR is designed to supply information upon matters of an Educational character. Domestic matters—the legitimate theme of the FAMILY FRIEND—cannot be introduced here. Before our Pupils proceed to question us upon any subject, they should refer to the Indexes of former volumes, as it is probable, from the great number of questions answered, that the information they seek may have been already supplied. We shall be happy to include in this department suggestions from Parents and Teachers upon Educational subjects.

1 — Welsh Language. M. S. — The Armoric language now spoken in Brittany, in France, is a dialect of the Welsh — that province being peopled with a colony from Britain in the fourth century; and although the two people have been separated so many ages, still the two languages contain a strong resemblance.

2 — Geography for Children. W. J. — The child should have an idea of the relations of size, form, and space, as well as number, before commencing geography. These, however, he acquires naturally at an early age; and very thoroughly, if the teacher has taken a little pains to aid him on these points in the earliest stages of his progress. A map is a picture, and hence a child welcomes it.

3 — First Steamboat in England. J. R. — The first steamboat used in Great Britain was the *Comet*—a small vessel of forty feet keel and ten feet and a-half beam, with an engine of three horse power, which carried passengers on the river Clyde, in Scotland, in 1811; two years later, the *Elizabeth*, of eight horse power, and the *Clyde* of fourteen horse power, were built and used on the same river.

4 — School Teachers. B. — As a candidate for the office of the teacher you should look well to your motives. It is easy to enter upon the duties of the teacher without preparation; it is easy to do it without that lofty purpose which an enlightened conscience would ever demand; but it is not so easy to undo the mischief which a single mistake may produce in the mind of the child, at that tender period when mistakes are most likely to be made.

5 — Entering into Business. J. C. T. — Your own acknowledgment of inexperience should deter you from the undertaking. One necessary pre-requisite to success in business is a thorough knowledge of that branch into which a man

enters. It is, therefore, always a hazardous step for any one to commence a business of the details of which he is ignorant, no matter how flattering may be the inducements held out. This is a prominent cause of failure.

6 — Correction of Children in Schools. T. R. — We are decidedly averse to corporeal punishment. Reproof, judiciously administered, is one of the most effectual means that can be used. As a general rule, this is best administered privately. The child's spirit of obstinacy is very likely to exhibit itself in the presence of his fellows; but in private, the conscience is free to act, and the child very readily submits. It is always perfectly safe to reprove privately; that is, not in the presence of the school.

7 — Invention of the Telescope. J. J. — The glory of the precise invention of the telescope at the beginning of the seventeenth century, may fairly be given to Hans Lippersheim, a spectacles-maker at Middleburg, a native of Wesel, not, as was formerly supposed, to Zacharias Jansen. The former, it is said, was led to the discovery by his children, who, when at play, put some of their father's prepared spectacles-glasses into a paper tube, and so saw the weather-cock of the tower greatly magnified.

8 — Self-Education. M. S. E. — Self-education is something very different from mere reading by way of amusement. It requires prolonged and laborious study. The cultivation of a taste for reading is all very well; but mere reading does little toward advancing any one in the world—little toward preparing him for a higher station than the one he fills. The knowledge which fits a man for eminence in any profession or calling, is not acquired without patient, long-continued, and earnest application.

9 — Smoking. J. S. C. — Smoking, besides its evil influence on health, is not a gentlemanly

practice, for the simple reason that it is a selfish habit, which is always disagreeable to others, while true gentility is a deference to the comfort, convenience, and frequently to the prejudices, of others. To have the room in which you are sitting filled with the fumes of tobacco, or to have the smoke of a cigar puffed in your face, is certainly very disagreeable; but it does not stop there: your clothes are filled with the vile odour, your handkerchief is rendered offensive and useless, and your lips are covered with a bitter and irritating deposit.

10—Iron, and the Magnet. J. R. C.—There are about nineteen valuable ores of iron, which are scattered over every part of the globe. The purer varieties, such as the native iron and the oxide, are found in greatest abundance in northern and polar latitudes. Their vast quantity in the latter locality has led to the belief that the poles (beneath the surface) must be one mass of native iron, capable of making the magnetic needle dip quite vertically there. This attractive property was first observed in some iron-stones brought from Asia Minor, and the most powerful being from the city of Magnesia, gave the name of magnets to this class of substances.

11—Works on Geography. D?—Our space will not admit of a lengthened list of works in this department of knowledge; we will mention a few which we think will facilitate your researches. Humboldt's "Cosmos." Milner's "Gallery of Nature." Cuvier on the "Revolutions of the Surface of the Globe." Guyot's "Comparative Physical Geography." Rennie's "Alphabet of Physical Geography." Hartley's "Outlines of Geography," contains perhaps all that is necessary in a book for first practice. "Nouvelle Geographie," par MM. Mussas-Michelot is one of the best I know, if not quite the best. Butler's "Outline Geographical Copy-Books" are useful for impressing on the mind the situations of places.

12—Egg-hatching by Steam. W. C. S.—If you are disposed to try the experiment and hatch eggs artificially, which may be accomplished by a spirit-lamp, placed under a small brooding-oven, or, if the oven is large, by several lamps, care must be taken that the eggs maintain a warmth which is neither too great nor too little. The due heat is about the temperature of our blood; on which account, persons who are compelled by a broken leg, or some not dangerous accident, to lie in bed for a space of time, may amuse themselves with hatching an egg, by placing it perhaps in the pit of the arm. The warmth which the body of a brooding hen gives out, is, however, somewhat greater than the vital

heat of the human body. Hence it is not injurious to the development in the eggs deposited in our small brooding-ovens, if the temperature is a little higher than that of the body.

13—Paper. E. J. C.—Paper is manufactured of vegetable matter reduced to a pulp by means of water and grinding. For the chief purpose to which it is applied in modern times, the ancients had recourse to a variety of materials; such as stone—tablets of wood, plates of lead, skins, parchment, linen, and, above all, the papyrus. Of all these articles, papyrus was found the most useful for ordinary purposes as a substitute for paper. The art of making papyrus into paper was invented in Egypt several centuries before the Christian era. The art of making paper of cotton, cloth, or rags, is supposed to have been borrowed from the Chinese or Persians, and introduced into Europe in the eleventh century by the Saracens; the practice of making linen into paper commenced in the twelfth or thirteenth century, and in France and England early in the fourteenth century.

14—Heraldry. M. Y.—For ourselves we look upon heraldry as simply one of those branches of knowledge which is useful in its proper place. The origin of the science—if it may properly be called a science—is intimately interwoven in the origin of history. When men became distinguished, and felt themselves animated by those natural feelings of pride and ambition, which distinction generates, they sought some method of marking to the eye their position; and, as the first means of distinction were military talents and courage, no readier method presented itself than that of placing a distinguishing sign or symbol on the shield, as the most conspicuous of the warrior's accoutrements. During long and glorious ages of the history of the world, such symbols were adopted amongst almost all peoples, and there can be no doubt that they constituted heraldry in the simplest acceptation of the word. But each armorial bearing was the badge of the individual, and spoke of himself but not of his family. It was under the feudalism of the middle ages only that heraldry was, or perhaps could be, reduced to a system such as it presents in our days. As far as we can trace it, the adoption of armorial bearings as family badges began in the latter half of the twelfth century. This is a fact which we believe is generally acknowledged, but we doubt much whether, as some suppose, the Crusades had anything to do with it, or whether it was anything more than a natural accompaniment of the peculiar progress of society in that age.

15—The Food of Bees. T. W. C.—The plants from which bees extract the greatest quantity of honey are:—Mignonette, heath, furze, white clover, thyme, particularly lemon thyme, rosemary, balm, beans, and every species of pulse, all resinous trees, borage, wild mustard, and golden-rod; this last begins to blow when all other flowers have faded, and continues to blow till the middle of November; it will grow in the worst soil, and should be particularly cultivated in the vicinity of an apiary.

16—Regular Studies. G.—We have not space to give you the list of works you require. We should strongly recommend you to pursue some particular study. It is better to know everything of something, than something of everything. Study, says Cicero—and no one ever had a better right to define study than he, for no man ever studied harder—is the intense and assiduous occupation of the mind, applied to some subject with earnest good will. One hour of study is worth a day of listless dawdling over a shelf of books.

17—French Language. H.—In the English language there are five consonant elements not in the French; these are the sounds of *th* in *thigh* and *thy*—*ch* in *church*—*je* in *judge*, and *ng* in *thing*. There are several simple vowel sounds, and compound vowel sounds or diphthongs, in the English, which are not in the French language; but to illustrate these would be useless and only confuse. In the Lessons on the French Language, we are now preparing for the *Family Tutor*, you will receive information on all the various points you require.

18—Ductility of Glass. E. M.—Although glass, when cold, is brittle, it is one of the most ductile bodies known in its melted state; if a thread of melted glass be drawn out, and fastened to a reel, the whole of the glass may be wound off; and by cutting the threads of a certain length, there is obtained a sort of feather glass. A thread of glass may be drawn, or spun so fine, as to be scarcely visible to the naked eye. Glass is very elastic and sonorous: fluoric acid dissolves it; it is by this acid, that engravings are made upon glass; and the alkalis act upon it when in a melted state.

19—Elasticity. S. E. L.—Elasticity seems to depend on a due proportion between attraction and porosity. If a body is perfectly compact, having no pores, then if you attempt to bend it the particles will suffer no compression on the side toward which you try to bend it, and it breaks as glass. If the substance be very porous, and the attraction strong, it will bend without breaking, as a stick of whalebone; or if it be compressed, it will restore itself, as an India-

rubber ball. If it be porous, but the cohesive attraction slight, it may be easily compressed, as a ball of butter, but will not restore itself to its former shape.

20—The Hanging gardens of Antiquity. J. C.—You are wrong in supposing that this is a fable. The hanging gardens, in antiquity called *Pensiles Horti*, were raised on arches by Nebuchadnezzar, King of Babylon, in order to gratify his wife, Amyctis, daughter of Astyages, King of Media. These gardens are supposed by Quintus Curtius to have been equal in height to the city, viz. 50 feet. They contained a square of 400 feet on every side, and were carried up into the air in several terraces laid one above another, and the ascent from terrace to terrace, was by stairs 10 feet wide.

21—Correct Pronunciation in Children. E.—You cannot be too particular in this matter. Nothing in their mental culture is perhaps so important to be taught *early* to children, as a habit of correct pronunciation. It need not occupy any additional time, since a faulty pronunciation is no more easily learned in the first instance, than a correct one; but when once acquired it can be changed only with the greatest difficulty. Erroneous habits,—as those engaged in the business of education well know—are far more difficult to eradicate than erroneous opinions. In order, however, to teach pupils to pronounce correctly, a *system* of pronunciation is indispensable.

22—Height of the Atmosphere. M.—Sir John Lubbock, according to the hypothesis adopted by him in his "Treatise on the Heat of Vapours," shows the density and temperature for a given height above the earth's surface. According to that hypothesis, at a height of fifteen miles the temperature is 240° 6' Fahr. below zero; the density is .03573; and the atmosphere ceases altogether at a height of 22.35 miles. M. Biot has verified a calculation of Lambert, who found, from the phenomena of twilight, the altitude of the atmosphere to be about eighteen miles. The condition of the higher regions of the atmosphere, according to the hypothesis adopted by Ivory, is very different, and extends to a much greater height.

23—Electrical Machines. F. H.—You are right in your conjecture. M. Munch discovered a means of causing an electrical machine to work in all weathers. This consists in tracing a slight line of tallow on each side of the plate from the centre to the circumference. If this be done in weather when scarcely anything can be got from the machine, it will be seen, from the first turn of the plate, that everything is changed, and that it will perform perfectly. If the glass

pillars which support the conductor are not covered with a coating of gum-lac, tallow should also be applied lightly to them, and then rubbed off with a dry cloth. It is evident that in these operations the object is to interpose an imperceptible coating of fatty matter between the surface of the glass and the ambient air charged with aqueous vapour.

24—Cleaning Microscope Glasses. W. C. R.—

When you clean the eye-glasses, do not remove more than one at a time, and be sure to replace it before you begin another; by this means you will be sure to preserve the component glasses in their proper places; recollect that if they become intermingled, they will be useless. Keep a piece of well-dusted chamois leather, slightly impregnated with some of the finest putty or crocus powder, in a little box to wipe them with—for it is of consequence to preserve it from dust and damp; the former will scratch the glasses, and the latter will prevent you from wiping them clean. As to the object-glasses, endeavour to keep them as clean as possible without wiping, and merely use a camel's-hair pencil to brush them with; for wiping them hard with anything has always a tendency to destroy their adjustment, unless they are firmly burnished into their cells.

25—School Lessons. T. H.—There is no fixed age for leaving school. This must altogether depend on the progress you have made in your studies. The great business of early education is to form habits of industry, to train the mind to find pleasure in intellectual effort, and to inspire a love of knowledge for its own sake. If you have attended school merely because it was expected of you; if you have learnt your lessons well for the sake of ranking high among your school-fellows; if you have regarded your studies as daily tasks to be performed till a certain period, when you will be released from them, you are still *uneducated*; what you have toiled to commit to memory will soon be forgotten, and your intellectual powers, in consequence of having never been properly called into action, will dwindle away, till it will be matter of wonder to yourselves, how you ever performed your school tasks.

26—Songs of Birds. B.—The experiments you refer to relate to those of M. De la Malle, of Paris. He was anxious to ascertain at what hour different birds began their morning song; he therefore, from the 1st of May to the 6th of July, made observations, which he regularly published. It appears that for thirty years this vigilant naturalist went to bed at seven o'clock in the evening, and rose at midnight, during

spring and summer, and that this habit was for scientific purposes. It seems that the concert is opened about one o'clock by the chaffinch, and that the sparrow is the laziest bird, not leaving his rest until five o'clock. In the intermediate hours, at marked intervals, which M. de la Malle has carefully noted down, other birds commence their natural melody. He has shown on more than one occasion, that the different birds have mistaken artificial light for the dawning of day, and that a solar lamp has awakened the little choristers.

27—Ruminating process of Animals. E. G.—

This process, ordinarily termed chewing the cud, is always connected, excepting individual instances, as in man and the kangaroo, with a complicated stomach, there being four, or at least four, distinct chambers whose structure is very different. The first, similar to the crop or craw of birds, is termed the paunch, and serves, by its heat and somewhat scanty moisture, to prepare the herbage for farther change. The second is termed the honey-comb bag, king's hood, or bonnet, is much smaller than the paunch, and is situated on the right of the lower end of the gullet, which opens in common into it and into the paunch. The third is the smallest of the four, and is named the many-plies. The pellet, when returned to the mouth is minutely chewed and reduced to a half fluid pulp, which, on being swallowed, is not solid enough to force open the always shut inlet of the paunch, and consequently passes to the third stomach, from which it is forwarded to the fourth.

28—Elementary Drawing. M. G.—We intend to devote some pages of our miscellany to instructions in drawing. The following directions will suffice for the present:—For the first lessons, let the pupil sketch the outline of some simple and familiar object, from a card, or from a drawing made by the teacher on the black board, as, a box, or cube. Then let a like or a similar object be taken, and its outline drawn, and the analogy observed between drawing from the card and the object. Thus a *practical* as well as a theoretical lesson will be learned at the same time. Let this practice be continued till the pupil becomes familiar with sketching simple objects. When the pupils have become sufficiently advanced, they should be taught to observe the analogy between the shading on the card and dark side of the object. That the pupil may the more readily learn to distinguish the division between the light and the dark side of an object, let him partially close his eyes and look at it. As soon as possible, and as a general rule, pupils should be required to draw from objects instead of cards.

29—Periods. F. S.—When numerals are written in capital letters, instead of figures or words, a period should be used after them; as Chap. VIII., page 120. When capital letters are employed as dates, they should be separated by dots, as they are divided when read; thus, M.DCCC.LIIII.—1853.

30—Commas. J. J.—Commas should *not* be inserted in the following cases,—between a *short* nominative and the verb, between words joined by *and*, between the governing and governed word, between the antecedent and relative—if *closely connected*, and between parts of a double or treble name.

31—Choice of Words. T. E.—We cannot give you, on this subject, a better recommendation than to remember the following rules:—Avoid obsolete, old-fashioned words, foreign terms when not necessary, vulgar contractions, slang, local terms, provincialisms, using one word for another, and all technical terms in general composition.

32—Phonography. D. — Phonography includes every method of writing by signs that represent the sounds of the language. It differs from Stenography in this respect:—Stenography uses characters to represent words by their spelling, instead of their sounds; hence phonography is much the shortest and simplest mode of shorthand writing.

33—Coke. H.—Coke burns without smoke, because it is the distilled coal remaining in the retorts after being freed from all gases and vapours. Dr. Arnott observes, that “a pound of coke produces nearly as much heat as a pound of coal;” but we must remember that a pound of coal gives only three-quarters of a pound of coke, although the latter is more bulky than the former.

34—Proper Age for School. W. S.—Children are often sent to school, for the purpose of learning, when they are too young. Usually, the age of five is as soon as a child should be placed in school; and when they can be properly taught at home, it is better to wait till seven or eight before subjecting them to the confinement of the school-room. It is said of the Rev. John Wesley that he was not taught the letters till he was five years of age, and that on his fifth birthday his mother taught him the alphabet, and the next day to read the first verse in the Bible.

35—Choice of College for Students. M. W.—By carefully consulting the Oxford and Cambridge calendars it may be seen if any and what circumstances, peculiar to the case of the youth in question, will give him advantages at one college which he could not obtain at any other. It

will be seen that many of the fellowships and scholarships are, by the wills of their founders, to be bestowed on the scholars who are of their own kindred, or natives of certain counties, or pupils of certain schools, in preference to other claimants.

36—Rain. T. C. H.—Rain falls in drops, because the vapoury particles attract each other in their descent, and those which are sufficiently near unite and form into drops. These drops are sometimes larger than at other times, because the rain-cloud is floating nearer the earth; when this is the case the drops are large, because such a cloud is more dense than one more elevated. The size of the drop is also increased according to the rapidity with which the vapours are condensed. Wind may sometimes increase the size of the drops by blowing two into one.

37—The Royal Navy. G.—The patronage of the royal navy is lodged solely with the Lords Commissioners of the Admiralty, and principally with the First Lord. Neither commissions nor promotions are to be purchased, as in the army; and the patronage, like that of the civil service, is chiefly bartered for parliamentary support. A young man must enter the service as a midshipman, and after six years' service in this rank he is made a mate. At this point he undergoes a very rigid examination as to his qualification to be made a lieutenant; the examination embraces, among other things, seamanship, gunnery, and trigonometry. If found qualified, he is “passed,” and then he must wait until his friends can beg a commission for him at the Admiralty.

38—Effect of Light and Air on Vegetables. B. F.—The effect of light and air on the sap of vegetables may be inferred from the fact that the sap in the stem and leaves of the common milk-weed is white; in the roots it has the appearance of water. The sap ascending in the woody part of large weeds will be seen to be watery, while the sap descending in the bark is often milky. Examine for yourself. Cut out a piece of bark, an inch square, on the limb of an apple-tree, a maple, or any other tree, in May or June, and watch the change that will take place during the summer. If you do not injure the wood, you will find an accumulation of matter along the upper edge of the square, which will extend downward till the square is covered. You will see, by such experiments, that the sap descends in the bark.

39—Phonetic and Phonotypy. S.—The word *Pho-net'-ic* is derived from a Greek word, signifying *voice*, and may be defined as a science which treats of the philosophy and principles of articulate sounds, as a means of communicating

thought from mind to mind. It also includes the various distinctions and modifications of tones, by articulation, inflection, emphasis, and modulation. It is the science on which Phonography and Phontotypy are founded. *Pho'-no-ty-py* signifies a method of printing, in which each sound of the voice shall be represented by a distinct letter or type. It will be readily seen, by any observer, that while our alphabet contains but twenty-six letters, the language, of which these letters are the elements, contains nearly forty sounds; consequently, many of the letters are used to represent several distinct sounds. For example,—*four* sounds are given to the letter *a*, as spoken in the following words,—*ale*, *arm*, *all*, *an*.

40—Punctual Attendance at School. H. C. M.—It is your duty to enforce a regular attendance at scholastic duties upon your son. One of the most fruitful sources of evil in school operations is the irregular attendance of pupils. If a school is properly classified, and the lessons explained and recited as they should be, no scholar can be absent from a single recitation without injury to himself, and detriment to the whole class. He injures himself, not only by losing the advantage of that recitation, but also by being less prepared to receive profit from the next. The whole class suffer on his account, because additional draught is made on the teacher to repeat to the delinquent scholar the explanation given to the class in his absence. Except in sickness, and in circumstances beyond human control, the parent, by permitting his children to be irregular at school, is not only injuring his own offspring, but also those of his neighbour. He may plead that he has a right to his own children, but can he plead any right to inflict this wrong on the children of his neighbour?

41—School-hours for Young Children. “A Father” will find that we have repeatedly expressed our opinion on this subject in the Appendix of the *Family Tutor*. We cannot, however, avoid recurring to this important topic. Young children are generally confined too long at a time in the school-room. One-third of the usual number of school-hours should be spent by them in the open air. They should be allowed two recesses each half-day of not less than fifteen minutes each. In addition to this, it is frequently desirable to dismiss them half an hour earlier than those pupils who are old enough to learn lessons. Even were health not taken into the account, such a course would be the better policy, for the pupil would not become so tired of confinement as to hate the school-room and all its associations. By this plan, they will not only love the school better but learn faster than when

confined six long hours each day. Then, when the health of the child is considered, a still stronger argument presents itself for less confinement.

42—Blacklead Pencils. G. D.—The easiest way of producing, not only blacklead, but all sorts of pencils, is by the following process, which combines simplicity, cheapness, and quality. Take white or pipeclay; put it into a tub of clean water, to soak for twelve hours, then agitate the whole, until it resembles milk; let it rest two or three minutes, and pour off the supernatant milky liquor into a second vessel; allow it to settle, pour off the clear and dry the residue on a filter. Then add blacklead, any quantity. Powder it and calcine it at a white heat in a loosely-covered crucible; cool and carefully repulverize, then add prepared clay, prepared plumbago, equal parts. Water to mix. Make them into a paste, and put it into oiled moulds of the size required; dry very gradually, and apply sufficient heat to give the required degree of hardness; lastly, the pieces should be taken carefully from the moulds and placed in the grooves of the cedar. The more clay and heat employed, the harder the crayon; less clay and heat of course produces a contrary effect. The shade of black may also be varied in the same way. Each mould must be made of four pieces of wood nicely fitted together.

43—Discoloration of Silver by Boiled Eggs. J. R. M.—It is well-known that silver, when brought in contact with eggs which have been heated, is blackened, and that this discoloration is owing to sulphuret of silver. It is usually admitted that this sulphuret is formed by the action of the sulphuretted oils supposed to exist in the yolk of the egg. M. Gobley, a scientific foreigner, not having found in this body anything of this nature, proceeded to examine into the causes of the phenomenon. He found that the yolk of an egg at the common temperature, and also when heated, does not discolour silver, even by contact of several hours' duration. He farther discovered that albumen, as procured from the egg, does not tarnish silver, but when heated it gives it a brown tint, which is stronger as the heat is greater. He therefore concludes that the discoloration of the silver is due to the sulphur contained in the albumen, and not to that supposed to exist in the yolk. By other experiments, he has ascertained that the sulphuret thus formed is not the result of the immediate action of the sulphur upon the silver, but by the application of heat the sulphur and the alkali of the albuminous matter, react upon each other so as to form a substance which is afterwards decomposed by this metal.

44—Short-hand Writers. H. M.—There are but between twenty and thirty short-hand writers in chief (if they may be so called), and each of these employs as many assistants and clerks as his business requires. The clerks are paid according to the quantity of their work, and a rapid and able hand may earn as much as £300 a year.

45—Merchant Service. R.—To enter the merchant service, a boy is usually apprenticed for three years. He should not be more than fifteen years of age, and fourteen is better than fifteen. To become a thorough good seaman, able, in nautical phrase, to hand, reef, and steer, he cannot have a better school than a ship of from 300 to 500 tons in the West India trade.

46—Commissions in the Army. T.—The ordinary mode of obtaining a commission is by purchase, and the applications for purchasing are said to be so numerous that a large proportion are necessarily refused. No candidate can be admitted into the junior department of the Royal Military College under the full age of thirteen years, nor above that of fifteen.

47—Harmony and Counterpoint. S.—The invention of the organ, first mentioned in the year 757, is supposed to have given the means of discovering harmony and counterpoint. And, in the eleventh century, an ingenious ecclesiastic, Magister Franco, is said to have been the inventor of a method of showing the time (or duration of sound), by a system of notation, and therefore must be considered the founder of the *science* of music.

48—Biography. E. G.—We have not space to admit a long list of works, which you might consult with profit. The following occur to us most readily. Gilpin's *Lives of the Reformers*—Account of the Gilpin Family, in Warner's *Literary Recollections*—Life of Elizabeth Smith and Henry Kirke White—Scott's *Lives of the Novelists*—Johnson's *Lives of the Poets*—Boswell's *Life of Johnson*—Madame D'Arblay's *Life of Dr. Burney*—Forbes's *Life of Beattie*—Life of Sir William Jones—Life and Correspondence of Cowper—Cunningham's *Lives of Painters and Sculptors*—Lives of Collingwood, Cuvier, Howard, Oberlin, Schiller, Wesley, &c., &c.

49—Physical Development. M. B.—By all means take lessons in gymnastics. It is our intention to introduce shortly in the pages of the *Family Tutor*, a few chapters on this important topic. The idea of physical development should never be forgotten in any study; no pursuit should place the child under unfavourable conditions of position, atmosphere, &c., and direct physical exercise should constantly ter-

minate the short periods of mental application. Lofty, well ventilated halls, and a large piece of ground, partly shaded by trees, should be essential elements of every establishment for education.

50—Hydrocarbons. M. T.—The number of hydrocarbons, or compounds of carbon and hydrogen, is very large, and they differ widely in chemical nature, as well as in physical properties; some of them are solids, like common coal, others are liquids, like spirit of turpentine, and a good many exist, under ordinary circumstances in the æriform state, as gases, such as common coal gas, they are, however, all of them combustible, and burn with greater or less facility in oxygen. As a general rule, the gaseous ones are most combustible: the solid ones the least so, simply because the former mix more easily with the oxygen than the latter, and hence, like the powdered charcoal, are able to burn more rapidly.

51—English Language. B.—Your observations are just. There is no language honoured by an earlier or worthier literature than the English; yet 1843 saw the publication of the first English grammar that deserves the name,—that of Dr. Latham, formerly professor of English at University College, London. As applied to other grammars, Dr. Latham's statement is no whit exaggerated, "that out of every hundred statements, made by the ancient writers on the English language, ninety-nine come under one of the two following predicaments: they either contain that which is incorrect and better not known at all, or something which was known before, and would have been known independent of any grammatical lessons whatever."

52—Cultivation of the Voice. J. J. C.—The difficulty of cultivating the voice consists in keeping its musical quality of tone pure while passing from one note to another, and in not allowing the bleating, or reedy quality of the common speaking voice, even in a modified form, to interfere with its beauty of tone; for it is the practical knowledge of using this pure quality of the voice which places one singer above another. In proof of this, how often do we find that a singer, attempting difficult vocal music, and even executing it with the greatest finish as regards precision and brilliancy, instead of inspiring us with feelings of pleasure, only annoys and wearies us during the performance; we feel bound to applaud the dexterity of the artist for the great perseverance in the study of music,—yet, at the same time, are heartily glad when the song is concluded.

53—Coral Reefs. W. — Most of your inquiries will be found answered in page 85, of the present volume. With regard to another question, we may state that the growth of corals of any magnitude is almost confined now to the warm seas of the tropics; and some of the varieties produced are familiar to every one in the beautiful red branching kinds, from which ornaments are often made. Other kinds, very commonly known, are the Madrepores and Brain corals, constantly met with under glass shades in drawing-rooms. All these build their habitations in nearly the same way, and the most vigorous are known to be chiefly confined to very moderate depths, in places where there is constant exposure to the action of the waves. They are often beautifully coloured while in the water, but lose all this beauty the moment they are removed.

54—Proper Station of Governesses. G. E. A. — By all means make an associate of the governess, if her merits entitle her to such confidence. The irksomeness of teaching young children is at times very great, however docile the children may be. Temper will assert itself, even in the most tractable; and the school-room is generally considered the choicest and fittest sulking ground. The wear and tear, the chafe, the weariness and harassment, which many hours' teaching must bring with it, should not be forgotten by the mother, in regulating the relations of the governess's room with the rest of the house. Although the school-room be the governess's domain, she should never be out of place in the drawing-room. If she be fit to teach and train children, she is fit company for the children's parents. And, if her manners or bearing be such as to make her unwelcome in the family circle, mothers may rely upon it, that all is not well in the school-room.

55—Rule of Conduct among Friends. E. J. R. We think you are too severe in your censure of the individual, for whom at the same time you profess great friendship. It should be settled as a principle in the mind never, by word, act, or smile, to countenance vice, or encourage that despicable spirit that finds delight in seeking out and magnifying the faults of others. If a young friend indulge in obscene remarks, do not laugh at him, but rather seek to change the subject of discourse. If he take more freedom, and speak of his immoralities, censure them as wrong without a moment's flinching from your duty, and do it with a degree of seriousness that will make him feel that you are in earnest. By an opposite course you will encourage vice:

but by this you may help a friend to shun evils that, if indulged in, will debase his mind, and make his influence in society a curse instead of a blessing.

56—Utility of Weeds. R. C. B. — Many plants we term weeds, have valuable medical qualities, and some may be applied to useful purposes, so as to pay something towards the expense of clearing them from the ground. Thus, sow-thistles (*Sonchus*) afford food for rabbits or hogs; the hog-weed or cow-parsnip (*Heracleum sphondylium*) is good for either swine or cattle; horses and asses are fond of young thistles when partially dried, and the seed may be prevented from spreading by gathering the down, which makes good pillows: however, there is some danger of trusting them to this stage of growth, as a high wind would, and frequently does, disperse them over a whole country. Charlock, when drawn, may be given to cows, who are very fond of it, particularly of the smooth kind; and it is stated that it can be converted into good hay. Nettles, fern, and the more bulky hedge weeds, are, in Staffordshire, collected annually, about midsummer, and burnt,—their ashes being afterwards formed into balls, which are of considerable value, being used in composing a ley for scouring and cleaning linen and other clothes.

57—Progress of Literature. F. H. — We are unable to give you the statistics you require. But the following statement may answer your purpose. It has been calculated that, if twelve men were employed for twenty-four hours a day, allowing neither for sleep nor meals, reading at the rate of eighty words per minute, they would barely keep up with the volumes published in London alone. In this, tracts and sermons are included; but if magazines, reviews, and newspapers, were added to the task, it would require upwards of forty men. If twelve hours per diem were employed, then eighty men would be required; and as he is a hard student who reads more than eight hours per day, so 120 men would finish the herculean labour; but, as the average amount of time spent in reading, even among the educated classes, seldom exceeds one hour per day, each person peruses one 960th part of the published mass: that is to say, to one book, chapter, or page, that he reads, he leaves 959 unread. The proportion of books which pay for the expenses of printing and publishing is small; of those which leave profit, very small; of those which reach a second edition, not one in 1,840; of those which pass through more than two, not one in many thousands.

58—*The Months.* C.—Our correspondent will find that his wishes are complied with. At the request of several pupils, we have commenced this series of instructive chronology, which will be continued through the year, each month being illustrated with a characteristic engraving. The biographical portion will necessarily be brief, but particular care will be taken to render the Natural History of the month complete and instructive.

59—*Clerkships in the Bank of England.* F. M.—About 800 clerks are employed in the Bank of England. The patronage is shared among the Directors, whose names are annually published in the almanacks, court calendars, directories, &c.; the Governor and Deputy-Governor having each a larger share than any other Director. Young men are not admissible as clerks under the age of seventeen, or over the age of twenty-five.

60—*Real Origin of the English Language.* W. S.—We should recommend you to consult Latham on the "English Language." In this work the Doctor states that the real origin of the English language is on the continent of Europe, and its real affinities are with certain languages there spoken. In fact, the native country of the English language is Germany, and the Germanic languages are those that are the most closely connected with our own. In Germany, languages and dialects, allied to each other, and allied to the mother tongue of the English, have been spoken from times anterior to history; and these, for most purposes of philology, may be considered as the aboriginal languages and dialects of that country.

61—*Sound.* J. J. W.—We are assured, upon good authority, that the unassisted human voice has been heard at the distance of 10 or 12 miles, namely, from New to Old Gibraltar. And in the famous sea-fight between the English and Dutch, in 1672, the sound of cannon was heard at the distance of 200 miles from the place of action. In both these cases the sound passed over water; and it is well known that sound may be always conveyed much further along a smooth than an uneven surface. Experiments have been instituted to ascertain how much water, as a conductor of sound, was better than land; and a person was heard to read very distinctly at the distance of 140 feet on the Thames, and on land he could not be heard farther than 76 feet.

62—*Chromatye.* S. B.—This is a new process of photography and consists in washing good letter paper with the following solution: Bichromate of potash, 10 grains; sulphate of

copper, 20 grains; distilled water 1 ounce. Papers prepared with this are of a pale yellow colour, and may be kept for any length of time, without injury, and are always ready for use. For copying botanical specimens, or engravings, nothing can be more beautiful. After the paper has been exposed to the influence of sunshine, with the object to be copied superposed, it is washed over in the dark, with a solution of nitrate of silver, of moderate strength; as soon as this is done, a very vivid positive picture makes its appearance, which then only requires washing in pure water.

63—*English Grammar.* R. E.—As an elementary work, we can refer you to the "Tutor's English Grammar." We have no space left to point out the advantage of a careful knowledge of grammar; besides, every well educated person ought to be aware of these. The use of grammar is well expressed by Cobbett: "Grammar, as I observed to you before, teaches us how to make use of words; that is to say, it teaches us how to make use of them in a proper manner, as I used to teach you how to sow and plant the beds in the garden; for you could have thrown about seeds and stuck in plants of some sort or other, in some way or other, without any teaching of mine; and so can anybody, without rules or instructions, put masses of words upon paper; but to be able to choose the words which ought to be employed, and to place them where they ought to be placed, we must become acquainted with certain principles and rules; and these principles and rules constitute what is called Grammar."

64—*Rotation of the Earth.* G. F. M.—The following process will prove the experiment of M. Foucault, by which the rotation of the earth on its axis is rendered visible:—Across the top of a central pier, which should be a hollow cone, thirty feet high, there is firmly fixed a wooden beam, having the centre perforated to admit the passage of a wire and the fixing of a Torsion Circle, such as is used with the Gauss Magnetometers. To the centre of this circle is attached one end of a silver wire, thirty feet long, of the size commonly known as "fine No. 6," and to the other end of this wire is fastened a metallic cylinder, weighing about four pounds, and terminating below in a conical point. On a platform directly below the weight and about thirty feet below the point of suspension, is inscribed a circle of six and a half feet diameter, with the requisite subdivisions and radii. After giving the pendulum an unbiassed arc of vibration, a few minutes' observation will suffice to show with certainty the motion of the earth on its

axis, as the terminating point of the weight will be seen, at each successive vibration, to arrive at the northern boundary of the circle a little more easterly than it did at the preceding one.

65—*Speaking Conducive to Health.* H. M.—We are glad that the lessons on Elocution we are now giving in the pages of our *Tutor*, have given pleasure to our correspondent and other friends. It is an undoubted fact that the practice of elocution is greatly beneficial to health. It is generally observed that teachers of all kinds who speak for many hours in the day, enjoy, considering their confined occupation, very good health. Indeed schoolmasters are proverbially “long-lived.” Ministers of religion are in general longer lived than the members of any other profession or trade. Besides their temperate habits, this is in no small degree to be attributed to their regular practice of exercising the lungs in speaking. They have almost entire immunity from diseases of these organs. Public lecturers are generally healthy and long-lived from the same reason. The great Cuvier was originally of a delicate constitution, and early threatened with symptoms of consumption in the lungs. But he was fortunately appointed to a lectureship, when he was required to speak some hours every day. His health soon began to improve, and at length became excellent, so that he lived to a great age. He himself attributed this result to the early exercise of his lungs in speaking.

66—*Muscular Exercise.* C. G.—A good state of health depends in a great measure on the proper exercise of *all the muscles*. But on looking at the greater portion of our industrial population,—artisans and workers in factories generally—we find them, in numerous instances, standing or sitting in forced and unnatural positions, using only a few of their muscles, while the others remain, comparatively speaking, unused or inactive. Sawyers, filers, tailors and many others may be easily recognised as they walk the streets, by the awkward movement and bearing impressed upon them by long habit. The stooping position especially tells most fatally upon the health; weavers, shoemakers, cotton-spinners, and dressmakers have generally a sallow and sickly appearance, very different from that of those whose occupation does not require them to stoop, or to remain long in a hurtful posture. Some years ago Mr. Thackrah, of Leeds, measured several tailors round the chest; the dimensions, instead of being 36 inches, were in most cases, only 33 inches. A statement was

published at the same time respecting an eminent tailoring establishment in London, in which 334 men were employed. Of this number not more than 6 had reached 60 years of age, and 3 of these were afflicted with curvature of the spine; 14 were about 50, and most of the others about 40.

67—*Growth of Sea-weeds from Seed.* W. J. I.—The case you allude to is probably that of Mr. Stackhouse, who, about fifty years ago, made this experiment. His plan was to get wide-mouthed jars with a syphon to draw out the water without shaking it. On the 7th of September, 1796, he placed plants of *Fucus canaliculatus* in the jar with their bases downwards. On the following morning he decanted the water into a basin. He then poured a fresh quantity of sea-water on the plants, and placed the jar in a window facing the south. On the following morning the plants discharged a few yellowish grains, which proved to be the actual seed of the plant; these seeds, however, were not in contact with the water, but each enveloped with a bright mucilaginous substance, which, from being heavier than the water, made it sink and caused it to adhere to the rock. Watching these seeds he had the pleasure of seeing one of them exploding so as to agitate the water, from which he learned that some sea-weeds, when ripe, scatter their sporules, by the bursting of the capsules without waiting for the decay of the frond. He next got pebbles from the sea-beach, and having drained off the greater part of the water, he poured the remainder on the pebbles, and left them to dry for some time that the seeds might adhere to them. He then fastened strings to the pebbles, and alternately sank them in the jar, and drew them out and left them exposed to sun and rain, in imitation of what would have been experienced by them by ebb and flow at mid-tide mark, had they been in their natural situation on the shore. In less than a week a thin film was discoverable on the surface of the pebbles. It gradually increased in breadth and thickness, until at last he observed buds arising from the membrane. These central shoots increased in size, but not rapidly after the first efforts; and as he had not an opportunity of placing them in a rock pool, owing to his being miles from the shore, he discontinued the experiments. More recently *Algæ* have been raised from seed by J. A. Agardh, and by some naturalists in our own country,—but still much remains to be done. There cannot be a branch of science more interesting than the study of *Algæ*, and we recommend it strongly to our pupils.

68—Fusible Metal. H. T.—You may make fusible metal by combining eight parts of bismuth with five parts of lead, and three of tin, when in a state of fusion.

69—Graphite. J. A.—This substance is commonly called *blacklead*, of which pencils are made. It derives its name from the Greek word *grapho*, I write. The finest graphite is found at Borrodale, in Cumberland, hence the name of the pencils “Cumberland lead pencils.” The substance itself is a peculiar form of mineral carbon with a little iron.

70—Transport. C. T. B.—The expression is commonly used, but it is not strictly correct. We know that persons under sentence of transportation are called transports, but until they have left this country they cannot be considered as such; because, transportation, according to law, is the sending away of criminals into a distant country, either for life or a term of years.

71—The Introduction of Coaches into England. F. J. S.—Taylor, the water poet, remarks at p. 240 of his work, that “One William Boonen, a Dutchman, brought first the use of coaches hither; and the said Boonen was Queen Elizabeth’s coachman; for, indeed, a coach was a strange monster in those days, and the sight of them put both horse and man into amazement.” The date of their introduction may therefore be fixed as 1564.

72—Migration of Fishes. T. B.—Like the tribe of birds, fishes, though inhabiting a medium of totally different properties from air, and one having the peculiarity of possessing great uniformity of temperature, are found to display many acts of migration, and casual movements in conformity with pressing wants or special objects of their being; their entire economy is altogether influenced by a range of circumstances very analogous to those contingent on the lives of other highly organized animals.

73—The Range of the Human Voice. C. T.—The range of the human voice is quite astounding,—there being about 9 perfect tones, but 17,592,186,044,515 different sounds; thus 14 direct muscles, alone, or together, produce 16,383; 30 indirect muscles, ditto, 173,741,823, and all in co-operation produce the number we have named; and these independently of different degrees of intensity. A man’s voice ranges from bass to tenor, the medium being what is called a barytone. The female voice ranges from contralto to soprano, the medium being termed a mezzo-soprano,—whereas, a boy’s voice is alto, or between a tenor and a treble.

74—Woad. W. J. J.—This plant was once cultivated to a great extent for the blue dye

extracted from it, but has been greatly superseded by indigo. It might still be cultivated to great advantage, as it improves the colour of indigo when mixed with it in a certain proportion. The plants, when just about flowering, are mown with a scythe, washed with water and sun dried; after this they are ground into a paste, which, kept in heaps for about a fortnight, is then formed and pressed into solid balls. It is also occasionally sown as food for cattle, and has lately been recommended for this purpose under the name of pastel.

75—Richard Cœur-de-Lion and the Bee-hives. R. B.—The anecdote you allude to is given as follows, in Ellis’s “Specimens of English Metrical Romance,” (vol II. p. 202, 223). “In the Metrical Romance of Richard Cœur-de-Lion, it is said that he took thirteen ship-loads of bee-hives with him; which, when he besieged Acre, he threw from a mangonel into the town. The Saracens were much annoyed by this, and said ‘King Richard was full fell
When his flies biten so well.’

There must have been some inconvenience in charging a machine with such instruments of offence.”

76—Incomes of the Colleges at Cambridge. H. P.—There are seventeen colleges at Cambridge; but five of the number, viz., Clare Hall, Corpus Christi, Caius, St. Catherine’s Hall, and Jesus, refused to make a return of their income and expenditure, to the University Commissioners. The gross incomes of the twelve colleges, at the present time, are given as follows:

	£	s.	d.		£	s.	d.
St. Peter’s	7,317	3	0	St. John’s	26,166	14	11
Pembroke	12,013	8	0	Magdalene	4,130	0	0
Trinity Hall	3,917	2	10	Trinity	34,521	19	10
King’s	26,857	7	11	Emmanuel	6,516	16	3
Queen’s	5,347	0	1	Sidney Sussex	5,392	16	10
Christ’s	9,178	15	5	Downing	7,239	17	0

The gross income of the seventeen colleges is estimated at not less than £185,000 per annum.

77—The Russian Empire. R. H.—Our limited space precludes the possibility of giving any lengthened notice respecting the Russian empire; but it is an undoubted fact that it has been rapidly increasing, as the following Table will show:

Year.	Area of square miles.	Population.
1462	100,000	6,000,000
1584	7,500,000	12,000,000
1689	14,500,000	16,000,000
1725	15,000,000	20,000,000
1825	20,500,000	55,000,000
1851	22,000,000	65,000,000.

78—The Rose. G. B.—This plant belongs to the natural order *Rosaceæ*, and is found in almost every country of the northern hemi-

sphere, both in the old and new world,—but not in Australia and South America. It is extensively cultivated in Syria, India, Persia, and other various parts of the East, for the purpose of procuring the attar from its delicate petals. Professor Agassiz, in a lecture upon the trees of America, stated a remarkable fact in regard to the family of the rose (which includes among its varieties not only many of the beautiful flowers which are known, but also the richest fruits, such as the apple, pear, peach, plum, apricot, cherry, strawberry, raspberry, blackberry, &c.), namely, that no fossils of plants, belonging to this family, have ever been discovered by geologists. This he regarded as conclusive evidence that the introduction of this family of plants upon the earth was coeval with or subsequent to the creation of man, to whose comfort and happiness they seem especially designed by Providence to contribute.

79—Lymphatic Vessels. J. M.—You are evidently mistaken with regard to these small vessels, because they are also called absorbents. Lymphatic and absorbent vessels are not distinct, they are one and the same. In anatomical language they are termed *vasa lymphatica*, and are divided into two sets, viz., lymphatics and lacteals. The former carry lymph, and the latter only absorb chyle, the product of digestion, but understand distinctly that they are absorbents

nevertheless, because they absorb or suck up certain substances placed in contact with them, and convey them into the current of the circulation. These vessels are very small, have thin transparent coats, and appear white when filled with their fluid contents during life; and, therefore, in order to examine them properly they are injected with size and vermilion, or with mercury. When these vessels are examined with a magnifying glass, they look like jointed tubes as *a* in the annexed figure, the joints indicating the position of the valves which are seen in *b* in the same figure, which represents one of these vessels laid open. The lacteals are confined to the cavity of the abdomen or belly, while the lymphatics are diffused through the body at large.

80—Language of Lawyers. S. B. — It is a general complaint that the language of the law is too verbose, and hundreds, nay thousands, have made the same complaint as yourself. A curious and amusing example of this prolixity was given a short time ago, by a clergyman who was delivering a lecture before

the members of a scientific institution in the west of England. "If" said the lecturer, "a man would, according to law, give to another an orange, instead of saying, 'I give you that orange,' which one would think would be what is called in legal phraseology 'an absolute conveyance of all right and title therein,' the phrase would run thus:—I give you all and singular my estate and interest, right, title, and claim, and advantage of and in that orange with all its rind, skin, juice, pulp, and pips, and all right and advantages therein, with full power to bite, cut, suck, and otherwise eat the same, or give the same away, as fully and effectually as I, the said A. B, am now entitled to bite, cut, suck, or otherwise eat the same orange, or give the same away, with or without its rind, skin, juice, pulp, or pips, anything heretofore or hereinafter, or in any other deed or deeds, instrument or instruments, of what nature or kind soever, to the contrary in anywise notwithstanding;" with much more to the same effect. Such is the language of lawyers."

81—Emphasis. C. M. G.—Emphasis in elocution, is the enforcing a meaning by laying a stress upon particular words or syllables. It is divided by some writers into emphasis of force, and emphasis of sense; the former is laid upon nearly every significant word, while the latter only singles out particular words from the sentence. Emphasis is capricious, being left to the will of the speaker. No doubt you have heard or read of the example given by Mr. Sheridan, of a sentence composed of six words which may have five different interpretations given to it, by emphasis; "Shall you ride to town to-morrow?" By placing the emphasis on all the words with the exception of *to*, it gives five different significations, but we think it is capable of six, because by making the sentence "Shall you ride to town to-morrow?" would imply that the person might not ride *to* but from town. With regard to emphasis in writing, the same rule holds good, because you should always write as you speak. In a toll case tried at Bedford, some time ago, Mr. Devon, who was brought from the Record office to produce some translations from "Doomsday Book," stated in his evidence the singular fact "that in many old manuscripts, when particular emphasis was given to a word, it was customary, instead of underlining it as at the present day, to run the pen completely across the word in the same manner as we now erase it." This information is worth attending to by antiquarians. For any further information on emphasis, consult the "Tutor's English Grammar," in Vol. I.

82—The Ancient Roman Foot. D. R.—From investigations made at Herculaneum and Pompeii, it appears that the ancient Roman foot was 0.29624 of a metre, or 131.325 lines, French measure.

83—Beheading. H. R. M.—Beheading was introduced into England by William the Conqueror; the first victim being Waltheof, Earl of Huntingdon, &c., who was executed in this manner, 1074.

84—Earth and Sun. J. B.—The earth is composed of matter four times denser than that of the sun; and hence the quantity of matter in the sun is between two and three hundred thousand times greater than that which is contained in the earth.

85—Cromlechs. W. M.—These erections are found almost throughout Europe, Asia, and its isles, and even in North America. They were devoted to religious worship and rites, under the Druidical government. Specimens may be seen on Salisbury Plain.

86—Origin of the Macedonians. P. R.—The Macedonians were a Grecian race, whose first history dates back to about the year 1300, A. M. (900 B. C.) They obtained their highest political power about the year 3650 A. M., under Alexander the Great.

87—The Study of Languages. S. T.—All languages are not of equal importance. We should advise you to learn English thoroughly, and, therefore, recommend you to study the English Grammar published in our first volume; then study Latin, from which almost all the other languages are derived, and this will assist you in the French lessons we are now publishing.

88—Magnetism. H. W.—Dr. Marachini, of Rome, so long ago as 1813, supposed that the violet rays of the solar spectrum possessed the property of magnetising needles, which he afterwards proved. Any person may perform the experiment for themselves. Mix an equiangular prism of flint glass in a hole in the window-shutter, and having obtained the solar spectrum, take a sewing needle, about an inch long, and entirely devoid of magnetism; cover one half of it with writing paper, and expose the other half to the violet rays of the spectrum, cast upon a panel at the distance of five feet. Allow it to remain for two hours, and you will then find the exposed end has acquired a north polarity. The indigo, blue, and green rays produce the same effect, though in a less degree.

89—Frugality. E.—You judge rightly in estimating the *Tutor's* willingness to advise

you in the matter of daily expenditure. Do as you propose. Keep a daily and exact account of your expenditure, and balance it weekly. By this means you will obtain habits of method and frugality, which will secure your happiness in life. Most young people, of both sexes, are going too fast in their expenses. They dress too much, and pay too high a tax for the gratifications of amusement and appetite. There are scores and hundreds of young men who cannot get started in business, and cannot settle in life, because they have never learned to graduate their expenses by their income. If, in their expenses, they would contrive to fall habitually a little *short* of their income, instead of going a little *beyond* it, a few years would establish them in an independent business.

90—Flax. M. C.—Of the flax plant there are several varieties in cultivation, the best seed coming from the Riga and Holland. As the different varieties arrive at maturity at different times, and the stem rises to different heights, it is very essential that the seed be not mixed, as this would occasion great inconveniences and loss in the pulling of the flax. The most common variety of flax in Great Britain, is of a moderate length, with a strong stem. If it is not sown very thick, it will throw out branches at the top, and produce much seed. It is, therefore, a matter of calculation whether it will be most profitable to have finer flax, with less seed, or an inferior quality of flax and an abundance of seed. There is a small variety which does not rise above a foot, grows fast, and ripens its seed sooner. When the principal object is to get linseed, this variety is preferred; but the flax is shorter and also coarser.

91—Overcoming Bad Habits. C. S.—Bad habits are easily acquired, but not so readily left off. However, we have not the least doubt but that you may overcome the one you have contracted, by firmness and perseverance. The late Mr. Loudon, the celebrated writer on Gardening, &c., during the time he was suffering so severely from the pain in his arm, found no ease but from taking laudanum, and he became at last so habituated to its use, that he took a wine-glassful every eight hours. After the amputation of his arm, however, he wished to leave off taking it, as he was aware of its injurious effects upon his general health; and he contrived to cure himself by putting a wine-glassful of water in his quart bottle of laudanum every time he took out a wine-glassful of the potion, so that the mixture became gradually

weaker every day, till at last it was little more than water, and he found he had cured himself of this dangerous habit without experiencing any inconvenience.

92—Quotations. M. B.—*Auribus teneo lupum*, (I hold a wolf by the ears). This quotation is from Terence, and is similar to our expression of “I have caught a Tartar,” which is said to have arisen from the fact of a trooper meeting a Tartar, who took him prisoner, and then calling out to his comrade, “Arrah! Pat, I’ve caught a Tartar.” “Have you,” said Pat, “then bring him along.” “I would,” rejoined the trooper, “but he won’t come.” “Then faith, come without him.” “Och! but he won’t let me!” *Lingua mali pars pessima servi*, (The tongue is the worst part of a bad servant). This is from Juvenal, and so is the third quotation, *Vacuis cantat coram latrone viator*, (The man with an empty purse may sing before the robber), meaning of course that he has nothing to lose. We are unable to discover the author of the French proverb “*La faim chasse le loup du bois*,” (Famine drives the wolf from the wood). We imagine that it is one of the common proverbs that is not acknowledged by any one in particular, like the old English proverb with a similar meaning, “Hunger breaks through stone walls.”

93—The Ancient Egyptian Cubit. A.—A commission, consisting of two members of the Academy of Inscriptions and Belles-Lettres, and three members of the Academy of Sciences, in France, was appointed in 1828, to examine the Egyptian cubit. The report presented by M. Girard to the Academy of Sciences, of Paris, is highly interesting. It appears that M. Girard discovered the standard of measurement in 1799, in the ancient Nilometer of the isle of Elephantine. This unit of measure was divided into twenty-eight fingers, and into seven palms; its absolute length was 527 millimetres = 20.748 English inches. M. Drovetti, the French consul-general in Egypt, discovered another standard in 1822, at Memphis. This was divided into seven palms; its length being 523.53 millimetres = 20.61 English inches. The third standard, also discovered at Memphis, by M. Drovetti, was divided into seven palms, and was 525 millimetres in length, or = 20.669 English inches. Other standards were discovered, from which the commission arrived at the conclusion, that the mean value of the ancient Egyptian cubit may be stated at 20.68875 inches English measure.

94—The Terms used in Geography. C. T.M.—The principal terms used in geography, respect-

ing the description of land and water, were explained in the System of Geography published in our second volume. As you complain of being unable to remember them, perhaps the following lines will assist your memory:

“A *continent*’s a tract of land defined,
Comprising countries not by seas disjoined;
The watery element an *island* bounds,
And everywhere with circling waves surrounds;
And a *peninsula*’s an earthly space,
Which (one part only) flowing waves embrace;
That part, or neck, which joins it to the main,
By the word *isthmus* fully we explain.
A *promontory* is, as all agree,
A point of land projecting in the sea;
The earthy globe the surging *oceans* bound,
And lesser *seas* more narrow shores surround;
For an inferior sea a *gulph* may stand,
Almost enclosed, and circumscribed by land;
A *bay* is as a smaller gulf defined;
A *creek*’s a smaller bay, less moved by wind;
A *road* is where a ship may ride with ease;
A *strait*’s a narrow pass that joins two seas;
A *lake*’s an inland sea with certain bounds,
Which banking earth on every side surrounds;
A *river* through the land meandering goes,
Streams from its source, and to the ocean flows.”

95—The Biscayan Language. J. M.—Astarloa, in his defence of the Biscayan language, observes, that one of the greatest proofs of its antiquity, is that instead of counting by tens, it counts by twenties. “That the fingers were the basis of numeration is testified by Ovid. The Greeks and Romans, who used the figures, I, II, III, &c., and the Chinese, who use —, =, ≡, &c., to signify one, two, and three, &c., seem to sanction this opinion. Among the Ætolians, *pempozein*, to count by five, means, absolutely, to count. Several of the American nations further confirm our system.” Among the Guanarians, five is called *popetei*, a word composed of *po*, hand, and *potei*, one, or one hand. To express ten, *pomocoi*, or two hands. Among the Iulians, twenty is called *iselujaron*, a word composed of *is*, hand, *elu*, foot, and *jaron*, all; or, all the fingers and toes. The Jarurians express the number twenty by *canipume*, a word composed of *cani*, one, and *pume*, a man, or one man; and the number forty by *noenipume*, or two men. But without crossing the Atlantic, we may find in Europe languages in which numeration takes place by twenties. Such are the Icelandic and Celtic. In the latter, for example, twenty is called *uguent*; and forty, sixty, are called *daou-uguent*, *tri-uguent*; that is, two twenties, three twenties.”

96—Inorganic Bodies. J. B.—Inorganic bodies are bodies devoid of life, such as rocks, crystals, metals, clays, minerals, &c.

97—Ancient measurement of Land. L. B.—The usual measurement was as follows:—100 acres equal to 1 hide; 5 hides, 1 knight's fee; and 40 hides a barony.

98—The Invention of Bells. H. J.—Paulinus, the Bishop of Nova, in Campania, is said to have invented bells about the year 400, and they were first used in churches in the year 900.

99—The use of the Letter K. J. P.—This letter was used as a numeral for 250, but if it had a stroke over it thus, $\bar{K}$, it signified 250,000. It is used as an abbreviation for knight; as, K. C. B., Knight Commander of the Bath; K. G., Knight of the Garter, &c.

100—Pinchbeck. G. M.—This alloy derives its name from being brought into notice by a person of the name of Pinchbeck. It may be made by combining three parts of zinc with four of copper. It was formerly used to make the cases of watches and brooch settings.

101—Spongy Platinum. H. F.—The spongy platinum is not platinum black. It is made by heating the ammonio-chloride of platinum until all the volatile particles are driven off, and the residue appearing like a spongy mass; it is called spongy platinum.

102—The University of Heidelberg. J. T.—This celebrated University was founded in 1386, at which time it was the only establishment in Germany where all the principal branches of science were taught. The elector of the Rhine Palatinate, Rupert I., was the founder.

103—Velocity of the Wind. B. H.—Captain Beaufort's scale of the hourly velocity of the wind is as follows:—Light air, 0.1 mile; light breeze, 5 miles; gentle breeze, 10 miles; moderate breeze, 15 miles; fresh breeze, 20 miles; strong breeze, 25 miles; moderate gale, 30 miles; fresh gale, 45 miles; strong gale, 50 miles; heavy gale, 70 miles; storm, 80 miles; hurricane, 100 miles and upwards.

104—Measurement of *Ætna*. E. S.—We are not aware of any measurements of *Ætna* taken since Captain Smyth's, which were as follows:—

	feet.
The summit.....	10,874
Foot of the cone.....	9,760
Casa Inglese (English hut).....	9,592
Highest part of the woody region....	6,279
Grotto de Capu.....	2,362
Nicolisi Convent.....	2,449

105—The Roman Names of the Days of the Week. S. P.—Sunday was called *Dies Solis*, or the Sun's day; Monday, *Dies Lunæ*, or the Moon's

day; Tuesday, *Dies Martis*, or Mar's day; Wednesday, *Dies Mercurii*, or Mercury's day; Thursday, *Dies Jovis*, or Jupiter's day; Friday, *Dies Veneris*, or Venus's day; and Saturday, *Dies Saturni*, or Saturn's day. The reason they were named thus, was because they considered each of these deities to preside over the day dedicated to them.

106—Founding of St. Petersburg. F. A.—Peter the Great was the founder of this city, and he employed more than 40,000 men to accomplish his object. Forests were uprooted and carried away, ditches dug, banks raised, and morasses drained, in which last operation upwards of 10,000 men perished in the morasses from want of food and shelter. Russians, Kalmucs, and Cossacks were the chief labourers, and the peasants from all parts of the empire were pressed to the work.

107—Population of the Ionian Islands. G. C.—We believe that the number of the inhabitants of the Republic of the Seven Islands, according to the last census, was as follows:—In the Island of Corfu—(town), 17,689, (country), 48,469 = 66,158; Cephalonia, 62,156; Zante, 39,725; Santa Maura, 17,386; Ithaca, 10,358; Paxo, 9,496; Cerigo, 5,193. The total being 210,498. According to the stipulations of the treaty of Paris, the Ionian Islands pay £35,000 annually to Great Britain; the average revenue being about £160,000 per annum.

108—Study of History and Biography. T. M.—There is no doubt that the study of history and biography, when carefully followed, is of incalculable advantage to young men entering upon the world's arena. It fits them for the bar, the church, the busy life of commerce, or the offices of the state. If they moralize upon the conduct of the men set forth in history or biographies, they will learn to avoid their errors, and imitate their good qualities, and make them believe that there is not only a general, but a particular Providence, that watches over us.

109—Phidias. C. R.—Phidias was born in the 73 Olympiad. He devoted himself to painting, when he was twenty-four years of age, and ornamented the temple of Jupiter Olympius, at Athens, with his works. The finest buildings in that city were erected between the 82nd and the 87th Olympiads, by order of Pericles, and under the direction of Phidias. His masters in the art of sculpture were Hippias and Agaladas. The Pallas of the Parthenon was produced in the 85th Olympiad, and was followed by that of Jupiter Olympius. He died in prison in the first year of the 87th Olympiad, having fallen a victim to the hatred of the enemies of Pericles.

110—The Teredo. E. C. W.—The teredo is a bivalve shell fish, or one that has two shells like a cockle, oyster, &c. It is known as the ship-worm, and is technically called the *Teredo navalis*. It bores holes in the piles of embankments and ships' bottoms (when not copper). As a defence against it, the under-water portion of woodwork in dock-yards has been studded with broad-headed iron nails. Like most molluscs, the teredo, though fixed when adult, is free in its young state, and consequently enabled to migrate and attach itself wherever mischief can be done by it. Thus ships at sea are attacked, and no wood has yet been found capable of defying its efforts. Even teak and sissoo woods, hard as they are, dissolve before it with rapidity; and though the chemical process of kyanizing timber successfully defeats the ravages of time, it fails before the voracity of the teredo. However, a remedy against its ravages has at last been discovered, which consists in Burnettizing the wood, or saturating it with "Sir William Burnett's solution of chloride of zinc." From numerous experiments, it has been found that this process effectually prevents the attack of the teredo.

111—Pitt's Bridge. J. D.—Blackfriars Bridge was originally called Pitt's Bridge, in honour of William Pitt, the great Earl of Chatham. It was built by Robert Mylne, a Scotch architect, and the first stone was laid on the 31st of October, 1760. There is a metal tablet inscribed in Latin, placed in the foundation stone, of which the following is a translation: "On the last day of October, in the year 1760, and in the beginning of the most auspicious reign of George the Third, Sir Thomas Chitty, Knight, Lord Mayor, laid the first stone of this bridge, undertaken by the Common Council of London, during the progress of a raging war (*flagrante bello*), for the ornament and convenience of the City; Robert Mylne being the architect. In order that there might be handed down to posterity a monument of the affection of the City of London for the man who, by the power of his genius, by his highmindedness and courage (under the Divine favour and happy auspices of George the Second), restored, increased, and secured the British empire in Asia, Africa, and America, and restored the ancient reputation and power of his country amongst the nations of Europe, the citizens of London have unanimously voted this bridge to be inscribed with the name of William Pitt."

112—The Colossus of Rhodes. A. H. N.—This celebrated statue was considered one of the wonders of the world, and was erected in honour of Apollo. It was made of brass, and was 70

cubits, or about 105 feet in height, being proportionably big in every part. It stood astride over the haven, so that ships could sail in and out between the legs. In one hand it held a light-house, in the other a sceptre; and its head represented a golden sun. The distance between the two feet was 1,000 yards, and two men could scarcely embrace its thumb, when their arms were extended. This extraordinary statue was made by Chares a Rhodian, who was engaged 12 years in its perfection. After it had stood for 66 years, an earthquake displaced it, and the money collected by the Rhodians from the various Grecian states being embezzled, the statue was never replaced or repaired, as intended; but the image was allowed to remain 894 years upon the ground, when the Saracens having taken the city, sold the "world's wonder," to a Jew as old brass; its weight being 720,000 lb. avoirdupoise. The Jew broke it into pieces, and loaded 900 camels with them. At the present time there is a castle erected on one side, and a town on the other, to mark the places where the feet of the far-famed Colossus were placed.

113—Discipline. H. B. W.—We are strong advocates for discipline, but it should not be harsh and tyrannical; it should be carried out with firmness, not severity. We remember reading of an instance of a young man being obliged to have his right hand amputated above the wrist, in consequence of the severe system—not discipline—exercised by his schoolmaster. It appears that when he was a boy of about seven or eight years of age, and just going to a boy's school, he committed some breach of school discipline, which raised the ire of the master of the establishment, who in his indignation, told the lad to "hold out his hand," and he then struck it violently with a ruler, after the semi-barbarous fashion of applying the "cuts" of the cane so much in vogue at one time. The blow "told." The little fellow's hand became exceedingly tender in one spot over the joint below the first finger. Gradually the pain increased till the hand could not be used. At length a soft bleeding cancer developed itself, and all ordinary remedies having failed, seventeen years of suffering were terminated as above, and a fine young man, the sole survivor of eleven sons, thrown mutilated upon his aged parents' hands. The same schoolmaster was known to have lamed another boy by similar violence. If the system of severity of which you complain does not cease, we strongly advise you to lose no time in removing your son from the school. We had hoped that such a barbarous system of correction had been generally laid aside.

114—Metrical Psalmody. W. W.—Luther was the inventor of metrical psalmody, about 1517, and it spread with the Reformation. The first tunes were the popular airs and dances.

115—Tycho Brahe. T. C. F.—Tycho Brahe was a Danish gentleman, born in 1546, who devoted himself to astronomy, and was the preceptor of Kepler; he imagined a system in contrariety to that of Copernicus, in which he placed the earth in the centre, the moon next the earth, with the sun at a distance, making Mercury and Venus the sun's two satellites.

116—Reporters. W. J. J.—The salary paid to a reporter at the commencement of his career is, we think, between £250 and £300 a year. Those who have been longest on the establishments, and are most useful, are occasionally employed on journeys and other special occasions, from which some additional remuneration is obtained. It is understood that the proprietors of the morning papers act liberally by the persons in their employment if they find them useful.

117—Singularity. J. M.—Avoid singularity; it does not betoken good-breeding, and is an insult to civil society. Dr. Johnson's advice was to gain the name of being eccentric, for then, said he, "you will have seated yourself in an easy chair for life." We advise you to act as you think proper and consistent with your duty, but not to *affect* independence of the world and indifference to public opinion: it is a great error for a young man to commit. Dr. Johnson's advice has done much harm.

118—The City of Rome. B. P.—We cannot furnish all the information you request, as there is a considerable difficulty in obtaining the official returns; however, we can inform you that there are 54 parishes, inhabited by 35,988 families; and that there are 41 bishops, 1533 priests, 2845 monks, and 1472 nuns. The Jews, who are about from 8000 to 10,000, are not comprised in this estimate. The whole population in 1837 was 156,552; in 1840, 154,632; in 1845, 167,160; and in 1846, 170,100.

119—Early Tuition of Children. S. C.—Children can only be taught the right construction of words in sentences by imitation; when the expression is erroneous, the parent or teacher should correct and make them repeat the whole over again. They receive at an early age an impress that lasts through life, and due attention to this matter in youth will not only prevent the necessity of much unlearning when they are able to appreciate the rules of grammar, but also lay a sure foundation for elegant writing and conversation in future.

120—Copernicus. G. R.—The benefit conferred to astronomy by Copernicus was confined to

his establishing the fact that the earth is a planet, instead of being the fixed centre of the universe; from which he inferred the general character of the solar system: viz., that it consists of a grand central luminary, around which a number of small opaque bodies or planets revolve. For answers to your other questions, we must refer you to the Fourth Volume of the *Family Tutor*, the leading subject of which is Astronomy.

121—Mineral Food of Plants. S. J. C.—This consists of carbonate acid, water, and ammonia, all of which are obtained from the atmosphere, and of sulphur (sulphuric acid), phosphorus (phosphoric acid), alkalies, earths, salts, and metals, all derived from the soil. Without the aid of the matters derived from the soil, the most abundant supply of carbonic acid, water, and ammonia, is of no use. But if a soil contain these necessary substances, plants will thrive in it, even if they have no carbonic acid or ammonia furnished in the shape of manure beyond the usual atmospheric supply.

122—Conduct to Teachers. R. C.—A scrupulous attention to politeness is not only useful to prevent hurting the feelings of others, but it is the best shield to your own delicacy; and as there are all sorts of masters, it is best to maintain a strict reserve, never talking of your private concerns, never speaking freely of persons, never indulging in jokes and laughter, because that leads to familiarity which may be unpleasant. Serious politeness is the best shield a young lady can have, and a shield you may need in a *tête-à-tête* with a youthful instructor; this sort of defence protects you, without offending others.

123—Good-humour. E. T. W.—Governesses, as you observe, have much to contend with, and a large amount of patience is necessary in combating the indolence and insubordination of youth; but with this admission, we think that you have allowed ideal grievances to obtain a mastery over your judgment. Be assured that a smile and a kind word will gain you the goodwill and attention of your pupils, while frowns and severity will have an opposite effect:—

"It is gentle good-humour that makes life so sweet,

And picks up the flowers that garnish our feet,
Then from them extracting the balsam of health,
Turn the blossoms of nature to true sterling wealth."

124—Mediæval and Middle Ages. T. L.—We have endeavoured to discover the *exact* meaning of these terms, which, as you observe, "are now so constantly sounding in our ears," but have not been able to satisfy ourselves. In the absence of better information, we subjoin the

following remarks from our contemporary, *Notes and Queries*. The late lamented Rev. J. G. Dowling, in his Introduction to the "Critical Study of Ecclesiastical History," fixes upon the Council of Chalcedon, A. D. 451, as the commencement of the Mediæval, or Middle Ages, which he thinks ended with the revival of classical literature in the fifteenth century, "that age of transition and revolution, combining in itself several of the most striking characteristics of the two states of society between which it forms the interval."

125—Squinting. P.—The operation for curing distorted vision is certainly attended with pain. You might try the following method with your child. Place him directly before you and let him close the undistorted eye, and look at you with the other. When you find the axis of the eye fixed directly upon you, bid him endeavour to keep it in that situation, and open his other eye: you will now see the distorted eye turn away from you towards his nose, and the axis of the other eye will be turned towards you. *But with patience and repeated trials*, he will by degrees be able to keep his distorted eye fixed upon you, at least for some little time; and when you have brought him to keep the axes of both eyes fixed upon you, as you stand directly before him, you may change his posture; setting him first a little on one side and then on the other. When in all these situations he can perfectly and readily turn the axes of both eyes towards you, the cure is effected.

126—Choice of a Profession. C.—Do not force your son into a career for which he appears to have an aversion. If he prefers the law, and your position in life enables you to gratify his wishes, with the confidence which you appear to have of his steadiness and abilities, there is little doubt of his success. It is said of Bacon, Lord Chancellor of England,—“While he was yet a child, the signs of genius, for which he was in after life distinguished, could not have escaped the notice of his intelligent parents. They must have been conscious of his extraordinary powers, and of their responsibility, that, upon the right direction of his mind, his future eminence, whether as a statesman or as a philosopher, almost wholly depended. In his twelfth year he was meditating upon the laws of the imagination. At thirteen, he was sent, fully prepared, to the University of Cambridge.” In one of his essays, Bacon says, “Custom is most perfect when it beginneth in young years; this is what we call education, which is, in effect, but an early custom.” And yet this same wise man says:—“The mould of a man’s fortunes is in his own hands.”

127—Respiration of Animals. T. E.—It has been ascertained that warm-blooded animals exhale nitrogen in proportion, from one fiftieth to one hundredth or less, to the oxygen breathed. Animals deprived of food absorb nitrogen in proportions similar to those in which it is exhaled in the first cases. Animals, when ill, or suffering from unusual food, also absorb nitrogen. With animals nourished on pernicious food, the carbonic acid exhaled is generally nearly equivalent to the oxygen inhaled. When fed on animal food, the proportion of carbonic acid is much less, in some cases not more than six parts to ten of the oxygen inhaled. Consumption of oxygen, compared with the weight of the animal, is ten times greater in the case of small animals, like sparrows, than with larger ones, like fowls. With hibernating animals, such as marmots, no unusual phenomena are presented when awake, but in their torpid state they consume much less oxygen, can live in an atmosphere which would not support them when awake, give off but little carbonic acid, and absorb so much oxygen and nitrogen as frequently to increase in weight by respiration alone. Cold-blooded animals consume very little oxygen, and breathe considerably through the skin; insects require as much oxygen as mammals.

128—Facility in Writing. R. T.—It is not your fault that you cannot write quickly, it is more your misfortune. Some persons possess great facility in writing, and their thoughts appear to flow almost faster than the ink from the pen they use. Mirabeau was a quick writer; and we might mention many authors who have written well and yet rapidly; among others, Power, who wrote very rapidly when he was in the humour. It is said that one night after he had partaken of his supper, and was sitting alone with one of his sons, then a boy, he desired him to light the candles, and arrange his writing materials ready in the bath-room. “Fred,” said he, “I will wager you a sovereign, and lend you the money to pay it if you lose, that what I write to-night, you will take double the time to copy to-morrow.” The next morning, at breakfast, he produced the entire manuscript of the farce called *How to Pay the Rent*, on which he bestowed very few additions or alterations. We do not advise you to cultivate the art of writing rapidly, but rather to write slowly and correctly, after bestowing much thought upon the subject. If you have not numbered many summers, we advise you to set aside your manuscript for a time, and then to look it over again before committing its precepts to the world’s criticising eyes. This practice is adopted by some of our most distinguished authors.

129—Entomological Society. W. C. S.—Members are admitted by ballot, on the recommendation of three members. Admission fee, two guineas,—annual payment, one guinea.

130—Measures of Capacity. T. S.—A table-spoonful is about half a fluid ounce, or four drachms; a teaspoonful one fluid drachm; a dessert spoonful two fluid drachms. A teacupful is three to four fluid ounces, and a wine-glass, one and a half fluid ounce.

131—The Mint. W. H. L.—There are several regulations to be observed for admission to the Royal Mint; but these may be known on an application being made to the master, or deputy master in writing, describing name and abode and the number of the proposed visitors, which must not exceed six in all.

132—Sir Isaac Newton's Reflecting Telescope. J. J.—This curious relic is not in the British Museum, as you suppose, but in the keeping of the Royal Society. Upon the stand is the following inscription: "The first Reflecting Telescope, invented by Sir Isaac Newton, and made with his own hands in the year 1671."

133—Private School Exhibitions. S. S.—There are several among the private proprietary schools that make an exhibition-fund a part of their plan. The Kensington school, and the Western grammar school at Brompton, belong to this number. The exhibition from the Kensington school is £50 a year for three years: the scholar, or rather his parents or guardians, having the choice both of university and college.

134—Vegetable Diet. C. H.—Food should be simple; not of too little nor too great variety. The structure of the teeth, resembling at once those of animals that naturally subsist on flesh, and of animals that take only vegetable food, and the character and length of the digestive organs holding a medium between the average of these two classes, indicate that a variety of food, animal and vegetable, is natural to man, and in most cases probably necessary.

135—Relative Value of Money. W.—We have not space to give you the information desired. We may remark, however, that in monetary comparisons of the present with former periods of British History, two considerations are essential. First, the relative quantity and purity of the precious metals contained in coins of the same denomination; and secondly, the relative prices of commodities, or the quantities of labour and other articles of consumption, for which a given sum of money will exchange at the respective periods of comparison.

136—Art Education. M. J. J.—Every painter, to succeed, must be a man of genius, and must possess the power of seeing, compre-

hending, and analysing, as well as delineating the beauties of nature in a degree superior to that which belongs to ordinary faculties. A parent would be wanting in common sense who should educate as a painter or sculptor a child who had evinced no talent for the imitative art. It must be assumed, therefore, that the talent exists, and, at an early age, begins to render itself manifest by unequivocal signs, before the question of education presents itself to the mind of the parent.

137—National Collection of Coins. J. S. C.—Our national collection of ancient money dates from 1753, when the bequest of Sir Hans Sloane of his coins and other antiquities formed its commencement. The Russian collections, though of modern formation, already contain some thousands of interesting coins. The Madrid collection contains 2,672 coins of gold, 30,692 of silver, and 51,186 of copper. That of Vienna is much more extensive; containing 24,112 Greek coins of all metals, 30,902 Roman, and 38,000 of the middle ages. But that of Paris surpasses all others in numbers, and in more than one class, both the rarity and beauty of its specimens are unrivalled.

138—Transfer of Engravings on Glass. R. G.—Metallic colours prepared and mixed with fat oil are applied to the stamp on the engraved brass. Wipe with the hand in the manner of the printers of coloured plates; take a proof on a sheet of silver paper, which is immediately transferred on the tablet of glass destined to be painted, being careful to turn the coloured side against the glass; it adheres to it, and as soon as the copy is quite dry, take off the superfluous paper by washing it with a sponge: there will remain only the colour transferred to the glass; it is fixed by passing the glass through the ovens. The basis of all the colours employed in painting on glass are oxidated metallic substances. In painting on glass it is necessary that the matter should be very transparent.

139—Ages of Roman Literature. W.—The golden age is generally computed from the time of the second Punic war to the latter end of the reign of Augustus Cæsar, and comprehends the oldest authors in the Latin tongue now extant, excepting the fragments of Livius Andronicus; though, for a considerable time after the commencement of this period, the language was but yet forming, and by gradual improvements afterwards arrived at its most perfect state under Augustus. The silver age is reckoned to have commenced on the death of Augustus, and continued to the end of Trajan's reign. The brazen age began at the death of Trajan, and

lasted till the time that Rome was taken by the Goths, about four hundred and ten years after the birth of Christ. The iron age commenced from the sacking of Rome above mentioned; after which, the purity and beauty of the Latin tongue declined.

140—The Vegetable Kingdom. T.—You are incorrect in your supposition. In the vegetable kingdom the respiration is the exact opposite of ours—they throwing out oxygen, and taking carbonic acid. Were they swept away from the earth, our leases of living on it would be short indeed. The Persian poet, Saadi, wrote a beautiful fable of the rose and the nightingale, which proves that he understood, as a philosopher, the harmony which he sang as a poet. The nightingale is imprisoned in a cage of glass, with a rose-bush in full bloom. Each gives life to the other. Deprived of fresh air, the bird would soon cease to swell his little throat with harmony. The rose greedily absorbs the air which has been rejected by its loved philomel, and blushes to brighter tints; respire, transforms, and returns it purified, to be again inhaled by the bird, which again decomposes it, to be neutralized anew by the rose. When the bird at length expires, singing its dirge of gratitude, the rose-bush withers and dies.

141—Water-Telescope. H.—This consists of a tube of metal or wood, of a convenient length, to enable a person looking over the gunnel of a boat to rest the head on the one end, while the other is below the surface of the water; the upper end is so formed that the head may rest on it, both eyes seeing freely into the tube. In the lower end is fixed (water-tight) a plate of glass, which when used is to be kept under the surface of the water. A convenient size for the instrument is to make the length three feet, and the mouth, where the face is applied, of an irregular oval form, that both eyes may see freely into the tube, with an indentation on one side to facilitate breathing, so that the moisture of the breath may not be thrown inside of the tube. Handles for holding the instrument are to be affixed to each side. The glass at the extremity of the tube should be surrounded with a rim of lead, one fourth of an inch thick and projecting forward three inches, so as to form a continuation of the tube. The weight of the lead serves both to sink the tube and in some measure to protect the glass. Holes should be made at the junction of the rim with the glass, in order to allow the air to escape and bring the water in contact with the glass.

142—Instinct and Reason of Insects. G. B.—Some philosophers argue that the wonderful

habits of some insects imply a no inconsiderable portion of reason. Kirby, in his "Introduction to Entomology," has devoted several pages to this subject, which you will find exceedingly interesting. Dr. Franklin was of opinion that ants could communicate their ideas to each other, in proof of which he gives the following anecdote: Having placed a pot containing treacle in a closet infested with ants, these insects found their way into it, and were feasting very heartily when he discovered them. He then shook them out, and suspended the pot by a string from the ceiling. By chance, one ant remained, which, after eating its fill, with some difficulty found its way up the string, and thence reaching the ceiling escaped by the wall to its nest. In less than half an hour, a great company of ants sallied out of their hole, climbed the ceiling, crept along the string into the pot, and began to eat again. This they continued until the treacle was all consumed, one swarm running up the string while another passed down. It seems indisputable that the one ant had, in this instance, conveyed news of the booty to his comrades, who would not otherwise have at once directed their steps in a body to the only accessible route.

143—False Etiquette. J. W. M.—The inquiries you make on the subject of etiquette, prove a strange ignorance of the ordinary usages of society. We are unwilling to occupy our space with matters familiar to most persons. Stiff and affected manners such as you evidently aim at, are as ill-placed as rude and unfeeling behaviour. The following anecdote shows to what absurdity etiquette may be carried. It is well to observe, however, that the scene is laid in Spain. Philip the Third was gravely seated by a fireside, where the firemaker of his court had kindled so great a quantity of wood that the monarch was nearly suffocated with heat, and his *grandeur* would not suffer him to rise from the chair, and the domestics could not *presume* to enter the apartment, because it was against the *etiquette*. At length the Marquis de Posa appeared, and the king ordered him to damp the fires; but he excused himself, alleging that he was forbidden by the *etiquette* to perform such a function, for which the Duke d'Usseda ought to be called upon, as it was his business. The duke departed, the fire burned with increasing fierceness, and the king endured it rather than derogate from his *dignity*; but his blood was heated to such a degree that an erysipelas of the head appeared the next day, which, succeeded by a violent fever, carried him off in 1621, in the twenty-fourth year of his age.

144—Numismatic Society. J. C. W.—Candidates for membership transmit their names to the Secretary, and are proposed and ballotted for in the usual way. The admission fee is one guinea, and the annual subscription thirty shillings.

145—Sound and Noise. C. E.—Philosophers make this distinction between *sound* and *noise*. Those actions which are confined to a single shock upon the ear, or a set of actions circumscribed within such limits as not to produce a continued sensation, are called a *noise*; while a succession of actions, which produce a continued sensation, are called a *sound*.

146—"Making" and "Manufacturing." H. M.—These terms are not synonymous. There is a considerable difference between them. *Making* refers to the production of a *small, manufacturing* to that of a very large number of individuals. Thus a person who makes boots for private individuals, is correctly termed a boot-maker; but another who makes boots for the army, is a boot manufacturer.

147—School Education. X.—Parents cannot possibly educate a child by itself at home. They may teach it certain rules of conduct—indeed, no species of instruction can entirely supersede maternal admonition—and also certain lessons from books; but to educate their child properly, they must allow it to mingle with other children, in order that its moral qualities may be duly developed by exercise.

148—Royal Military College at Woolwich. W. C.—No candidate will be nominated a cadet who is under fifteen or above seventeen years of age; a certificate of his birth, taken from the parish register, and signed by the minister and churchwardens, must be transmitted to the Master-general's Secretary, at the Ordnance Office in Pall Mall, and also an address where he may be sent for on a vacancy.

149—Dress of Governesses. T. W.—An ungraceful exterior is uninviting, while a graceful propriety of costume often makes upon children a favourable impression, that predisposes them in your favour, besides its being due to your employer and to yourself. Yet, that you may not wear a shabby garment, you must observe the economy both of time and purse; which your circumstances and your aim demand.

150—French Measures. W. C. M.—The fundamental standard adopted in France for the metrical system of weights and measures, is a quadrant of the meridian; that is to say, the distance from the equator to the north pole. This quadrant is divided into ten millions of equal parts, and one of these equal parts is called the *metre*, which is adopted as the unit of

length, and from which, by decimal multiplication and division, all other measures are derived.

151—Tobacco. E.—Tobacco, doubtless, with other kindred poisons, was intended for medicinal purposes. It is one of the most powerful agents which grows on the earth. It is one of the very strongest of poisons. It possesses about three times the power of opium in the same form. A single drop of the concentrated oil, put upon the tongue of the stoutest dog, will destroy life. It is said, by one writer, that if a man were to dip both of his hands into that oil, with a skilful surgeon by his side, his hands could not be amputated in time to save his life.

152—Pyramids. G.—Solids, which decrease gradually from the base, till they come to a point, are called *pyramids*. They are of different kinds, according to the figure of their bases. If the pyramid has a square base, it is called a *square pyramid*; if a triangular base, a *triangular pyramid*; if the base be a circle, a *circular pyramid*, or a *Cone*. The point in which the pyramid ends is called the *vertex*. A line through the centre of the pyramid, from the vertex to the base, is the *height*. The *frustum* of a pyramid is what remains, after any portion of the top has been cut off parallel to the base.

153—History of Greece. J. J.—You cannot do better than read Thirlwall's "Greece." The "Edinburgh Review," justly says of this work, that although the author's fancy is everywhere subject to his correct historical taste, the student will not fail to detect traces of the scholar, who delights in the graceful and lovely fictions of antiquity, which is so peculiarly attractive to minds of congenial temper. It animates the reader through the toilsome intricacy of some parts of his progress, like a brook by the wayside, which, although it only sparkles in the traveller's eye, yet enlivens him by the sense of its constant companionship.

154—Care of the Teeth. G. B.—It is incumbent on all to take proper care of their teeth, and for that purpose nuts and other hard substances should not be cracked by them; biting thread and string, and using metallic toothpicks, should be avoided, as by all these means the enamel is seriously injured. A soft brush and water should be used in cleaning the teeth and gums, directly upon rising in the morning, after every meal, and just before going to bed. Quills and thin-pointed slips of wood, make the best toothpicks. Very hot and very cold drinks injure the teeth, as do also tooth-powders, or washes of an acid nature, which act on the enamel.

155—First Post-Office in England. Q. Y.—The

Post-office was not established in England until the seventeenth century. A system of posts was established in England, in the time of Edward IV., about the year 1481, and Postmasters were appointed; but their business was confined to furnishing post-horses to the carriers of the government, and to persons who were desirous of travelling expeditiously, or who wished to send important packets upon special occasions. In 1635, Charles I. established a letter-office, for the transmission of letters between England and Scotland; but this extended only to a few of the principal roads; the times of carriage were uncertain, and the Postmasters on each road were required to furnish horses for the conveyance of the letters, at the rate of 2½d per mile. Dr. Brande says this establishment did not succeed, and that at the breaking out of the civil war, great difficulty was experienced in the transmission of letters. At length a Post-office, or a national establishment for the weekly conveyance of letters to all parts of the kingdom, was instituted by Cromwell in 1649.

156—To make Photogenic Drawings. R. D.—Place upon a flat surface a piece of the photogenic paper, with the prepared side upwards; upon this the object is to be delineated; cover it with a piece of flat glass, (plate glass is the best); expose this to diffused daylight, or, still better, to the direct rays of the sun, when that part of the paper not covered with the object will immediately become tinged with a violet colour, and if the paper be good, in a few minutes pass to a deep brown or bronze black colour. It must then be removed, as no good will be obtained by keeping it longer exposed; on the contrary, the delicate parts yet uncoloured will become in some degree affected. The photogenic paper will now show a more or less white and distinct representation of the object chosen. It must be evident that the closer the contact of the paper and object, the finer will be the outline. To accomplish this, it is common to take a book cover, or a piece of wood, and lay upon it first three or four folds of flannel, or, what is better, a pad of cotton wadding, the paper, object, and glass upon this, and to tie them together as tightly as possible, or else to place moderately heavy weights upon the corners of the glass.

157—Collecting Insects. A. B. C.—To fit insects for a cabinet, they require to be set, as it is termed; that is, all their parts must be placed in the manner best fitted to display them. For this purpose, each is pierced, when dead, with an insect pin, a fine slender sort, manufactured on purpose. Beetles ought to have the pins

passed through the shoulder of the right wing-case, and butterflies and other insects through the corslet, on a right line with the head, and a little back from it. While the insect is fresh and flexible, the legs and wings are to be stretched out with a setting needle, or a large pin bent at the point and fixed into a wooden handle, then stuck upon a board covered with cork and paper, and kept in their proper position by means of pins and braces until they become dry and stiff. The braces are made with slips of fine card, or thick hot pressed paper, stuck through at one end with a strong pin. When insects have become stiff before being set, they may be rendered flexible again by covering them over for several hours with a damp cloth, which, however, must not be permitted to touch them. A camel-hair peneil is used for brushing off dust when insects are very small; as piercing them with a pin would destroy them, it is usual to gum them on a slip of card or cut wafer, and to arrange this in the cabinet.

158—Night-closing Flowers. F. S.—Linnæus was not the discoverer of the night-closing properties of flowers. The subject has been alluded to by many of our old writers, and chiefly Chaucer and Shakspeare. To the Swedish naturalist, however, we are indebted for the most valuable and accurate knowledge. A circumstance which occurred in his own garden first led Linnæus to a series of investigations. A friend had sent him some seeds of a species of lotus. The red flowers which sprang from them excited his admiration, and as his gardener was absent when they came in bloom, Linnæus, immediately on his return, took him to the greenhouse to see this new floral treasure. It was evening, and with a lantern they proceeded to the spot; but what was the surprise and vexation of Linnæus at finding that his beautiful blossoms had quite disappeared! He concluded that they had been eaten by insects; but, on returning the next morning to his greenhouse, he saw them in full beauty upon the same part of the plant on which he had left them the preceding day. Again in the evening he accompanied the gardener to visit the plants, and again the flowers were gone, while the next morning once more exhibited them in full glory. His gardener declared that his master must have been mistaken, and that these could not be the same flowers, but must be fresh blossoms. Linnæus was too much of a philosopher to be satisfied with such an idle conclusion, and in the evening he examined the plant, carefully taking up leaf by leaf, until he discovered that the blossoms had been quite hidden by the drooping foliage.

159—Roman Computation of Money. W.—The Romans usually computed sums of money by *sestertii*, or *sestertia*. *Sestertium* is the name of a sum, not of a coin. When a numeral adjective is joined with *sestertii*, it means just so many sesterces; thus, *decem sestertii* = ten sesterces: but when it is joined with *sestertia*, it means so many thousand *sestertii*; thus, *decem sestertia* = 10,000 sesterces.

160—The Myrtle. G. H. M.—The name of the myrtle is derived from a Greek word signifying perfume. The volatile oil, which exists in glands in the bark and leaves of this plant, is the cause of its sweet odour. It is thought to have considerable effect in improving the hair, and is therefore a frequent ingredient in the pomade employed for this purpose. The whole plant has a singularly astringent property, and this is peculiarly partaken by the oil.

161—Inns of Court. W. T.—It was observed by Lord Mansfield, and his observation is fully supported by various orders in Dugdale's "*Origines Juridicales*," that the original institution of the inns of court nowhere precisely appears. They are voluntary societies, which for ages have submitted to government, analogous to other seminaries of learning. But all the power they have concerning the admission to the bar is delegated to them from the judges, and in every instance their conduct is subject to control.

162—Exercises for Young Ladies. C. E.—There are some games which might be played in the open air by grown-up young ladies with great propriety, if arrangements were made for the purpose; bows and arrows for archery, battle-door, calisthenics, and the skipping-rope, are very useful, as, by bringing the arms into play, they exercise the lungs. If, instead of sitting a whole-morning over your books and work, you would jump up at the end of every hour or two and use the dumb-bells, or skip the rope, for five or ten minutes, it would greatly help to keep your circulation brisk and healthy, and with daily walks might prove sufficient exercise.

163—Speaking Trumpets. E.—We cannot give you the origin of speaking trumpets. It is believed that they were more used formerly than now; they are certainly of great antiquity; Alexander the Great made use of such a contrivance to communicate his orders to the army; by means of which it is asserted he could make himself perfectly understood at the distance of ten or twelve miles. Stentor is celebrated by Homer as one who could call louder than fifty men: and from Stentor the speaking trumpet has been called the stentorophonic

164—Shells for Microscopic Observation. M.—The structure of shell has only lately attracted the attention of microscopists, but since the year 1842 the subject has been scientifically investigated by Mr. Bowerbank and Dr. Carpenter. According to the experiments of the latter gentleman, undertaken at the request and expense of the British Association, the calcareous matter in all shells is nearly equally crystalline in its aggregation, and the particular forms which their fracture presents are determined chiefly, though not entirely, by the arrangement of the animal basis of the shell, which possesses a more or less highly-organized structure.

165—Unaffected Ease. R.—Everything affected, stiff, artful, is repugnant to good taste and refinement. An appearance of unstudied, artless, easy simplicity, is one of the most fascinating of all graces. If associated with a pure, elevated, and benevolent mind, it makes a character of the highest finish. This is one of the most difficult graces to acquire and maintain, without degenerating to an unbecoming freedom and presumption of manner. While it is desirable to conduct yourself towards your friends, and, especially, those of your own age and rank, in an unconstrained, frank, open, and cordial manner, beware, also, if you would retain their friendship, that you always treat them with a delicate and respectful civility.

166—Situation of Teachers. W. C.—By all means pursue your intention of becoming a teacher, if your inclination and pursuits direct you to that career. As to the *respectability* of such a situation, there can be no doubt, so long as virtuous and manly principles and persevering industry characterise your conduct. Young men of talent and enterprize may rise as well in this, as in other professions. The duties of a teacher, however laborious, are, to a mind rightfully disposed, pleasing and ennobling:—

“Delightful task! to rear the tender thought,
And teach the young idea how to shoot,
To pour the fresh instruction o’er the mind,
To breathe the enlivening spirit, and to fix
The generous purpose in the glowing breast.”

167—English Grammar. C. W. H.—It is rare that a teacher is found without some pretensions to English Grammar; yet it is deplorable to observe how very few have any liberal or philosophical acquaintance with it. In many cases it is little else than a system of barren technicalities. The teacher studies *one* book, and too often takes that as his creed. In no science is it more necessary to be acquainted with several authors. The person who has studied but one

text-book on grammar, even if that be the best one extant, is but poorly qualified to teach this branch. There is a philosophy of language which the teacher should carefully study; and if within his power, he should have some acquaintance with the peculiar structure of other languages besides his own. It can hardly be expected that the common teacher should acquire an accurate knowledge of other languages without actually studying them.

168—*Different kinds of Poems.* B. H. J.—A poem on the celebration of a marriage is called an *EPITHALAMIUM*; on a mournful subject, an *ELEGY* or *LAMENTATION*; in praise of the Supreme Being, a *HYMN*; in praise of any person or thing, a *PANEGYRIC* or *ENCOMIUM*; on the vices of any one, a *SATIRE* or *INVECTIVE*; a poem to be inscribed on a tomb, an *EPITAPH*, &c. A short poem, adapted to the lyre or harp, is called an *ODE*, whence such compositions are called *Lyric Poems*: a poem in the form of a letter is called an *EPISTLE*: a short witty poem, playing on the fancies or conceits which arise from any subject, is called an *EPIGRAM*; as those of Catullus and Martial. A sharp, unexpected, lively turn of wit in the end of an epigram, is called its *Point*: a poem expressing the moral of any device or picture, is called an *EMBLEM*; a poem containing an obscure question to be explained, is called an *ÆNIGMA* or *RIDDLE*.

169—*Infant Schools.* M.—A list of the apparatus used in the Edinburgh Infant School will perhaps assist you. 19 boards of quadrupeds, 2 on each board, no descriptions; 3 boards of quadrupeds, 2 on each board, with descriptions; 35 boards of quadrupeds, 1 on each board, with descriptions; 15 boards of birds, one on each ditto, ditto; 24 boards of Scripture prints, with lessons; 46 boards of many objects used as post lessons; 11 boards of Scripture texts in large letters; 9 boards of geometrical figures, compass, and clock; 8 boards with reading lessons; 16 boards with Mr. Milne's alphabet and spelling sheets; 2 boards, owls; 100 slates, 1 tin box for slate pencils; 9 lesson posts, and 10 small stools; 12 chairs; 2 ladders; 3 large maps, the World, Europe, Scotland; 1 political chart; ball frame, or arithmeticon; large table in classroom; a desk; brass figures; brass goniograph; a number of minerals; shovel and rake for garden.

170—*The Voice.* J. J. W.—The lessons on Elocution given in our pages will answer the various questions you have proposed. A good idea of the process by which the human voice is enunciated may be had from the following operation:—Take the reed of a hautboy, put it be-

tween your lips, and blow into it, and a distinct sound is heard; press it a little with your lips, blowing as before, and the sound becomes more acute or shrill; press it still more, that is, bring the two sides of the reed closer, and the sound is still more acute. From this example, we may partly conceive in what manner the human voice is varied with respect to the acuteness or gravity of its tones. The glottis is found to be narrower in women and young persons than in men; and hence men's voices are deeper or graver than those of boys and women. And we can at pleasure dilate or contract this aperture, and so fashion the tones of our voice into every variety of the musical scale.

171—*Arithmetic.* H. C. R.—Although a knowledge of arithmetic may, in general, be well appreciated as a valuable acquisition, yet the effect produced on intellectual character, by the exercises necessary for acquiring that knowledge, is not always duly considered. In these exercises, the mental effort required in discovering the true relations of the data, tends to strengthen the power of comprehension, and leads to a habit of investigating; the certainty of the processes, and the indisputable correctness of the results, give clearness and activity of thought; and, in the systematic arrangement necessary to be observed in performing solutions, the mind is disciplined to order, and accustomed to that connected view of things, so indispensable to the formation of a sound judgment. These advantages, however, depend on the manner in which the science is taught; and they are gained, or lost, in proportion as the teaching is rational, or superficial.

172—*Cultivation of Memory in Children.* A. B. C.—Children can understand the first principles of mental philosophy much sooner than is generally supposed, and such information insures greater rapidity and thoroughness of progress. They should be taught that memory is the great storehouse of the mind, into which all sensations and perceptions are received, and where they for ever remain; but that to obtain a command over them, so as to be able to recall them at will, they must be often and regularly brought before consciousness; and for this purpose their studies require frequent reviewal. For the same object they may be encouraged in conversation on the subjects of their lessons, and explaining to one another difficult matters in them. This is a good means of keeping up classes to a uniform standard; all of them soon find that the more knowledge they impart the more they retain, and that the fountain increases in depth and purity by dispensing its waters.

173—Chapel. T. R.—Printing houses once bore the name of chapels, because a ruined chapel in Westminster Abbey was appropriated for this purpose by the celebrated Caxton.

174—Singing in Churches. Z.—The introduction of singing into the service of the church is supposed to be in that period when Leontius governed the church of Antioch; about the year of Christ, 347.

175—Dried Plants. A. B.—Plants for drying are better gathered in the middle of the day than either morning or evening, when they are wet with dew. Those should be selected for drying which have some flowers expanded, others gone to seed, and some of the lower leaves should always be preserved, and also the root, if small.

176—Vegetable Wax. H.—The myrtle tallow, or candleberry, has long been known in America, and occasionally collected for medicinal purposes, but never used as candles to take the place of spermaceti or tallow. The bush is from three to eight feet high. It yields a supply of 25 per cent. of wax. The wax is obtained by boiling the berries in water until the wax floats; it is then skimmed off.

177—Ancient Music. C. M.—By this expression is understood such musical pieces as were composed more particularly from the time of Palestrina to that of Handel and J. S. Bach, that is, from the year 1529 to 1684. Of the various and most distinguished composers, the following stand the most pre-eminent;—viz., Palestrina, Leo, Scarlatini, Durante, Jomelli, Caldara, Clari, Marcello, Fraeta, Pergolesi, Hasse, Sebastian Bach, and Handel.

178—Niebuhr's History of Rome. C. J. J.—If your inclination and leisure prompt you to a perusal of this work, you will learn from it much that is improving and interesting. It calls in question the authority of much of the early Roman history; and the author is a searching and profound antiquary. The first centuries of the Roman republic are intermingled, no doubt, with much beautiful fiction, created by national vanity, and at the same time with much solid truth.

179—Caoutchouc Trees. S. E.—There is not likely to be such a scarcity of these valuable trees as you suppose. In Assam, trees yielding caoutchouc grow in vast forests. One tree has been found with a trunk seventy feet in circumference, one hundred feet in height, and its branches expanding six hundred and ten feet in circuit. It has been estimated, after an accurate survey, that there are 43,240 such noble trees within a length of thirty miles and breadth of eight miles of forest near Ferozepore, in the district of Chardwar, in Assam.

180—Squirrels. T.—What you have read is no fiction. In Lapland large numbers of squirrels cross lakes upon pieces of bark and ice, putting up their tails to catch the breeze. The poet says:

“The river was wide, but on its tide
Each squirrel prepared to float;
With his bushy tail for his upright sail,
And the pine bark for his boat.
So, boldly his little bark he launch'd
On the stream, without delay;
His out-spread tail caught the passing gale,
And he merrily steer'd away.”

181—Gypsum. F. C.—Gypsum is the sulphate of lime, and of-course composed of sulphuric acid (oil of vitriol) and lime. In Italy and other countries, it appears in the form of alabaster, which receives a fine polish, and is translucent. When crystallized in transparent plates, it is called selenite (moonstone.) It sometimes appears in fine silky fibres, when it is called fibrous gypsum. Radiated gypsum is another beautiful variety of this mineral. Gypsum is a powerful manure, and is much used for ornamental work in plastering rooms; also for busts and casts of various kinds.

182—Magnitude. A. T.—Magnitude cannot be explained by definition. As Dr. Lardner observes, there is no magnitude so great, that we cannot conceive a greater, and none so small, that we cannot conceive a smaller. The diameter of the earth measures about 8,000 miles; but it is very small compared to the diameter of the sun, which measures nearly 900,000 miles: and this, again, is itself very small compared with the distance between the earth and the sun, which measures little less than 100,000,000 miles; and even this last space, great as it is, vanishes to nothing, compared with the distance between the sun and the fixed stars.

183—Objects and Pictures as a means of Education. H. P.—There can be no doubt whatever that the practice of producing in the presence of children sketches of objects, animals, vegetable products, and maps, as aids to illustration, is of great importance in teaching. Objects and pictures have always been in use, more or less, in home and in public education. Milton's mother used the Dutch tiles of her parlour fireside to teach her son natural history; and every mother knows how highly pictures and objects are valued by her children. The most systematic mode of teaching by objects in the public school was that by Pestalozzi. It was an important step in education, but it was but one step towards a thorough understanding of

the systematic mode of picturing out in words, which, in the ascending scale, includes every possible variety of condition which language can convey.

184—Cause of Waves. D. G. H.—The friction of the wind combines with the tide in agitating the surface of the ocean, and, according to the theory of undulations, each produces its effect independently of the other. Wind, however, not only raises waves, but causes a transfer of superficial water also. Attraction between the particles of air and water, as well as the pressure of the atmosphere, brings its lower stratum into adhesive contact with the surface of the sea. If the motion of the wind be parallel to the surface, there will still be friction, but the water will be smooth as a mirror; but if it be inclined, in however small a degree, a ripple will appear. The friction raises a minute wave, whose elevation protects the water beyond it from the wind, which consequently impinges on the surface at a small angle: thus, each impulse combining with the other produces an undulation which continually advances.

185—Elocution. T. M.—In page 107 of the present volume you will find some useful observations on defective articulation. The study of elocution is more important than your remarks seem to imply. The organs of speech, with few unfortunate exceptions, are possessed by all mankind; they are in constant use by all,—their functions are of the highest moment to all, whether for the display of the charms of song and poetry, the persuasion of oratory, the invocation of prayer, and the numberless exchanges of opinion and expression of the affections and emotions in social intercourse. The most rigid person, who would regard with distaste the exercises of the dance, and attach no importance to the graces of bodily movement, will still be as naturally and properly desirous of cultivating the voice, as the greatest advocate for worldly accomplishments. He does it in learning to sing the praises of his Maker, and when engaged in the exercise of prayer.

186—Proficiency in Music. E. G. M.—Persevere, and you will succeed. It has been truly said that one who begins music, and wishes to arrive at any degree of perfection, should, in order to conquer it, follow it up as he would a flying enemy, and recollect that, if he gives him a moment's rest, that enemy may then be able to rally, and conquer him; but if he perseveres, *without intermission*, he will gain the victory; and having secured possession of his object, he will always find that a long relaxation may be recovered in a few days' practice; whereas, if he relaxes before he has arrived at a certain

point, however great may be his talent or progress, he will undo in one half year what he learned in the other; and, in short, be undertaking a work like *Penelope's web*. As to an easy method of attaining knowledge of any kind, we should recommend, in preference, a grappling with difficulties, and a determination to overcome obstacles. Such, at least, is the practice of all original minds, and you will do well to follow the same plan.

187—Composition of Water. G. W.—Lavoisier, the celebrated French chemist, to whom theoretical chemistry is so much indebted, was the first to detect water to be a compound. In 1773, he succeeded in resolving it into its two constituents. Soon after this, in 1781, one of our own countrymen, Cavendish, found that its constituent elements could be made to unite; and that water might thus be artificially produced. He found, too, that the quantity of water obtained was exactly equal in weight to that of its two components; and showed that this fluid is one of the chief products in ordinary combustion. Not long afterwards, Humboldt and Gay Lussac ascertained the exact proportions, by measure, in which the two elements unite; and after this discovery, our knowledge of the composition of water may be considered as essentially complete. All that has since been done, in reference to this subject, by Berzelius, Dulong, and others, is, by aid of more refined experiments, to demonstrate these proportions to a greater degree of accuracy.

188—False Estimates of the Early Astronomers. I.—In the Fourth Volume of the *Tutor*, the leading Chapters of which are devoted to Astronomy, you will find the information you require. With respect to your question on the early astronomers, we may observe that a curious proof of our senses deceiving us more than our instruments, exists in the history of astronomy, in regard to the valuing of the apparent diameters of the stars. The first astronomers who occupied themselves with determining the angle under which the most brilliant stars which radiate from the heavens were seen, much exaggerated its size. Kepler attributed to Sirius an apparent diameter of 240 seconds; Tycho Brahe more than 126 seconds; and Albateginus, before them, make it 45 seconds. The diversity of these measures shows sufficiently how little confidence they should inspire; and the improvements in telescopes prove even the smallest to have been much exaggerated. Gassendi gave Sirius but ten seconds of apparent diameter. Galileo, Hevelius, and J. D. Cassini reduced the diameter to five or six seconds.

